SCIENTIFIC AMERICAN

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This view is taken at the bow looking aft. It shows eight 12-inch and four 4.7-inch guns trained directly ahead. This is the first ship to carry twelve 12-inch guns and she is the most powerful vessel in commission at the present time.

THE MIGHTY ARMAMENT OF THE NEW BRAZILIAN DREADNOUGHT "MINAS GERAES."—[See page 240.]

SCIENTIFIC AMERICAN

ESTABLISHED 1845

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NEW YORK, SATURDAY, MARCH 19th, 1910.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

A TRIUMPH OF MODERN STEAM ENGINEERING.

AMONG the many brilliant successes of the steam turbine, none surpasses the results which have been obtained at the Fifty-ninth Street power house, which operates the heavy service of the New York Subway. Here, by the introduction of a low-pressure turbine between the low-pressure cylinder exhaust and the condenser, not only has the output of the present reciprocating engine been doubled, but there has been made possible an increase of nearly 150 per cent in the economic capacity of the whole plant.

In a recent issue of the SCIENTIFIC AMERICAN we gave a preliminary statement of the truly remarkable work which is being done at this station. At that time one of the turbines was in place, and the tests had not been carried to full completion. In the interim, more complete data have been secured, and at the last meeting of the American Society of Mechanical Engineers a paper was given by H. G. Stott, Superintendent of Motive Power of the Interborough Company, and J. S. Pigott, in which a very complete statement of the installation and its results was made public.

During 1908 it became apparent that the rapidly increasing traffic in the Subway would render it necessary to provide additional power for the winter of 1909-1910. The main power plant consisted of nine 7,500-kilowatt (maximum rating) compound Corliss engines and three 1,250-kilowatt turbine units for lighting and signal purposes. Of these engines and generator units the authors of the paper say: "In general they are the most satisfactory large units ever built, as five years' experience with them has proved."

In considering the problem of securing an additional supply of power, electric transmission of power from a hydraulic plant was rejected because of the high cost of a double transmission line from the nearest available water power, and the impossibility of getting reliable service.

The gas engine, it will surprise many of our readers to learn, while offering the highest thermodynamic efficiency, would have cost at least 35 per cent more than an ordinary steam turbine plant, and its maintenance and operation account would have been from four to ten times greater.

The alternative of building more reciprocating engines of the type already installed was rejected (in spite of their most satisfactory performance) because of the high first cost and the small range of economical operation (between 3,300 and 6,300 kilowatts); the water rate rising very rapidly beyond these limits.

As between the installation of high-pressure and low-pressure turbines, it was found that, by combining a low-pressure turbine with the present engine, at least 8 per cent higher efficiency would be secured than with a high-pressure turbine unit alone; and it was finally decided to place an order for one 7,500-kilowatt (maximum rating) turbine unit, since by this means "the company would not only get an increase of 100 per cent in capacity of the combined engine and turbine," "but at the same time give the engines a new lease of life by bringing them up to a thermal efficiency higher than that obtained by any other type of steam plant."

The net results obtained with this first installation are summarized as follows: An increase of 100 per cent in maximum capacity of plant; an increase of 146 per cent in economical capacity of plant; a saving of approximately 85 per cent of the condensed steam for return to the boilers; an average improvement in economy of 13 per cent over the best high-pressure turbine results; an average improvement in economy of 25 per cent (between the limits of 7,000 kilowatts and 15,000 kilowatts) over the results obtained by the engine units alone; and lastly, an average unit thermal efficiency between the limits of 6,500 kilowatts and 15,500 kilowatts of 20.6 per cent.

These results are surely entitled to be considered as constituting the low-pressure turbine one of the greatest triumphs of modern steam engineering.

AN AMERICAN GIBRALTAR

KEY WEST, by virtue of its geographical position, stands in the same strategic relation to the Gulf of Mexico and the Caribbean Sea as does Gibraltar to the Mediterranean; and its naval and military importance, which have always been recognized, have been greatly increased by the results of the late Spanish war and the construction by the United States government of the Panama Canal. The transformation of Key West into a great naval and military station which shall rival in importance the fortress of Gibraltar is advocated at considerable length in an article by Commodore W. H. Beehler, U. S. N., Commandant of the Seventh Naval District, which appears in the March number of the Journal of the Military Service Institution. The first part of the Commodore's paper is devoted to an urgent plea for the more complete co-operation of the army and navy forces. The army and navy should be as intimately connected as are the navy and the marine corps, and this connection should include, as far as possible, both the personnel and material. Guns and ammunition should be of the same general type, with the latter interchangeable, and supplies and stores should all be of one standard. It is admitted that close relations between the army and navy would be subject to certain limitations; but the Commodore urges that it is essential that the coast artillery corps and the navy should be intimately associated for the efficient defense of our seaboard. There should be a definitely assigned portion of the navy to act as Navy-Coast-Defenders, and in this class should be included second-class battleships or older battleships, the smaller torpedo boats, scouts, submarines, mine-laying vessels, and tugs. "Their co-operation in the defense of any particular naval base should be definitely arranged in time of peace, and they should maneuver and drill, *now*, under the command of a designated officer of the coast defense service, whether he be an army or a naval officer."

In his proposal to make of Key West an impregnable Gibraltar, it is pointed out that the present defenses at Fort Taylor are inadequate, for the reason that battleships can lie at the entrance buoy seven miles south of Fort Taylor, beyond the range of the 12-inch rifle mortars, and destroy Key West from that point without being exposed to any danger, the remaining velocities of projectiles from the direct firing 10-inch and 12-inch guns being insufficient to penetrate the armor of any battleship; whereas these same caliber guns on a battleship could shell the city of Key West and completely destroy it.

This consideration brings the Commodore to his novel proposal for rendering Key West impregnable. He points out that in place of high hills or a huge rock as at Gibraltar, for the mounting of coast-defense guns, Key West Harbor, twenty-five miles in length, is sheltered on the north by a line of low reefs and shoals which form a complete protection on that side, while seven miles to the south of this line there is a parallel line of eastern shoals, some of which are scracely awash at low tide and none more than eight feet above high water. To build forts on these outer reefs would be so costly that it could scarcely be considered; but Commodore Beehler proposes to take our monitors and older battleships which have passed their period of usefulness on the high seas, mount them in selected positions upon these reefs, and utilize them as permanent turret forts. Thus, for instance, selecting the shoal known as Rock Key, where there is a small natural harbor, he would lighten the old monitor "Amphitrite" by the removal of her propelling engines, haul her into the harbor, build around the vessel a dyke of piling, rock, and riprap, and then fill in the space between the inner face of the dyke and the ship with material hydraulically dredged and deposited. He estimates that the work would not cost more than $50,000; and he claims that the sea-coast defenses would thus be increased by a double-turreted fort containing four 10-inch breech-loading rifles and provided with admirable protection. The vitals of the fort, that is the ammunition rooms, turret turning gear, etc., would be protected not only by the armor of the ship but also by many feet of the inclosing earth and riprap. The deck of the monitor would be about eight feet above mean low water, and the riprap would be carried up the sloping face and over on board, leaving only the turrets and superstructure exposed.

The ship as thus imbedded would furnish, says the Commodore, a complete, modern double-turreted fort, with every necessary feature to operate the guns, and with quarters for the officers and men of the garrison; and moreover, the entire cost of the installation would be less than the cost of maintaining such a ship in the navy for one year. The monitors "Miantonomah," "Terror," and "Puritan" could be installed upon the adjacent reefs, and the range of the sixteen 10-inch and 12-inch guns of these forts would command a large part of the Straits of Florida, and especially that part which is used by westbound vessels entering the Gulf of Mexico, which navigate close to the Florida reefs to avoid the strong current of the Gulf Stream. Incidentally, it may be mentioned that the dyke would be extended in each case to form a small harbor of refuge for torpedo boats and submarines. Referring to the proposed island fortifications for the defense of the entrances of the Chesapeake, it is suggested that it would be a great economy if one of our old battleships such as the "Oregon" were used as a central point about which the island could be built.

Now, it is a question of great interest and of unquestionable moment, whether this very novel proposal of the Commodore does not provide an opportunity to greatly lengthen the useful life of the battleship. In view of their enormous and rapidly growing first cost, the rapidity with which these instruments of war depreciate in military value is something appalling. In a few years after their completion they are unfit to lie in the first line of battle; in ten years' time they are becoming obsolete; and in fifteen years' time they must be relegated to the limited rôle of coast defense. The depreciation is not in the guns and armor but in the motive power, speed, and coal capacity. Many of these obsolescent ships, because of their powerful armor and armament, would be perfectly well able to stand up in the first fighting line, if they only possessed the requisite speed and maneuvering quality; and if it should be found practicable to utilize them in the way suggested by Commodore Beehler, their powerful guns and heavy protection would render them most formidable when mounted as part of the permanent fortifications of our sea-coast defenses. This suggestion is certain to excite a widespread interest, and we commend it for discussion in our columns by that large and ever-growing circle of our readers who follow closely the development of naval and military material.

PAULHAN'S FLIGHT NEAR NEW YORK.

AVIATOR LOUIS PAULHAN succeeded last week in getting the bond which he is required to put up in case he flies reduced to $6,000 for one week, and on Friday, March 11th, he made two exhibition flights at the race track near Jamaica, L. I., before some 300 invited guests. Wilbur Wright and his lawyers were interested spectators, as it was thought that M. Paulhan would attempt to fly with his vertical rudder tied, or else without using the stabilizing flaps or ailerons. There was an 8 to 10-mile breeze blowing, and by starting against the wind Paulhan left the ground after a run of about 75 feet. He rose rapidly, and in the course of the two circuits of the track, made in 2:44, he reached a height of 75 to 100 feet. The biplane flew well and was not affected appreciably by the wind. Despite the sharp turns the machine did not tip very much in making them. It appeared to rock and pitch slightly, but was always under perfect control. The descent was made rapidly and at an angle of about 20 degrees. M. Paulhan made two more circuits in 2 minutes and 38 seconds.

REQUIREMENTS FOR THE SCIENTIFIC AMERICAN TROPHY FOR 1910.

THE third annual competition for the handsome trophy given in 1907 to the Aero Club of America by the publishers of the SCIENTIFIC AMERICAN is now open to all aviators. As aviation has at last reached a stage where cross-country flights of a considerable distance are being made, it has been decided to award the trophy for 1910 to the aviator who makes the longest cross country flight in excess of 50 miles, which has been fixed as the minimum distance. A round-trip flight of 25 miles each way will also fulfill the conditions. The flight may be made at any point in the United States that is convenient for the aviator, who must notify the Aero Club of America or the SCIENTIFIC AMERICAN a sufficient time in advance to allow of the sending of a representative of the club to officially observe it. The competition is international, and foreign aviators are invited to compete for the trophy whenever occasion allows.

The dates of the international balloon and aeroplane races for the Bennett trophies have been fixed by the Aero Club of America. The balloon race will be held at St. Louis on October 17th, and the aeroplane race above the Hempstead, L. I., plains (probably) on October 22nd. Plans are also on foot to hold big aviation meets at San Antonio, Texas, in April, at Atlantic City, N. J., in July, and at St. Louis in October.

ENGINEERING.

The United States army has recently adopted a new type of machine gun which can be carried by one man, while two such guns with a full equipment of stands and ammunition can be packed upon a mule. The new weapon can be fired from the shoulder. The barrels are carried in duplicate, and can be rapidly changed when they become heated from continuous firing.

In a recent communication to Flight on the relative military value of aeroplanes and airships, Col. Capper of the British army believes that the improved aeroplane will have the dirigible at its mercy. He predicts that the future aeroplane will be able to ascend to heights of 10,000 feet and over, from which it will swoop down and destroy the more slowly moving dirigibles below.

The New Haven Railroad has proposed to the city of Boston to enter into the joint construction of a tunnel between the North and South stations in that city. They offer to spend $16,000,000 on the construction of the tunnel which is to be electrically operated, provided the city will bear the expense of $10,000,000, which it is estimated will be the cost of the purchase of the necessary land.

One of the most remarkable features of the New York Public Library, now slowly nearing completion, will be the huge stack room, 90 feet wide, 300 feet long, and 60 feet in height, containing seven tiers of stacks. The metal work of the stacks alone weighs about 3,000 tons, and recently, in estimating for the painting contract, it was found that merely to pass once through the multitudinous nests of stacks it would be necessary to cover seven miles of distance.

The last annual report on the shooting in the British navy shows that the percentage of hits to rounds fired during 1909 was 64.67. In 1905, it was 20.02; in 1906, 34.60; in 1907, 35.81, and in 1908, 58.32. The significance of these figures will be evident when it is stated that in 1907 the size of the target was greatly reduced, the number of hits in that year being consequently only slightly greater than in the year preceding.

The placing of a large order by the Admiralty for liquid fuel has led to exaggerated statements in the London Express to the effect that the British navy contemplates the practically exclusive use of oil fuel. There is no truth whatever in this statement. A few hundred tons of oil will be carried in future battleships as an auxiliary to coal, and oil will continue to be used as fuel in certain classes of torpedo boats. Great Britain possesses no such extensive oil fields as would warrant a drastic change of this character.

A general scheme for constructing a north breakwater to the entrance of the Panama Canal has been approved, and the preparatory work is being done. The breakwater will protect shipping in the harbor at Colon, and will shelter vessels which are making the north entrance to the canal from the violent "northers" which prevail from October to January. There will be two jetties of rock, which will extend from Toro and Manzanillo points until they reach depths of water of 48 and 44 feet, respectively.

Some injudicious statements were made recently by Representative Rainey about the new 14-inch coast defense gun, which is undergoing test at Sandy Hook, in the course of which he spoke of the gun as having "burst" on trial. As a matter of fact, the gun has shown excellent results, and given much satisfaction to the army men. The accident, which was a trivial one, consisted in the breaking of a part of the mechanism of the disappearing carriage, which delayed the tests only a few days, and was quickly made good.

It is now officially stated by the Pennsylvania Railroad Company that the four tubes under the East River and the electric service as far as Jamaica will be placed in operation on May 15th. The trains will run, under a five-minute headway, from the new terminal at Thirty-third Street to Jamaica, without a stop, in 18 minutes. The main yard, station, and offices on Long Island will be built at Jamaica, where $3,000,000 will be expended for this purpose. The tunnels to New Jersey will be in operation by July 1st, and the lines along the north shore to Great Neck early in January, 1911.

In London Engineering Mr. A. A. C. Swinton describes a model steam-propelled aeroplane built by C. A. Parsons of turbine fame, which made successful flights in 1893, thus antedating the Langley aerodrome by three years. The boiler, 2½ inches in diameter, supplied steam to a cylinder 1¼ by 2 inches, the total weight of engine, propeller, and water being 1¼ pounds. The aeroplane consisted of two wings and a tail built of a silk-covered, cane framework, the whole apparatus with engine weighing 3½ pounds. The model made several flights of about 100 yards distance, coming down when the steam pressure was exhausted. The boiler, which carried 50 pounds, was heated by a spirit lamp.

ELECTRICITY.

In an article in La Revue Electrique, on the effect of high temperature on insulating materials used in dynamo-electric machinery, it was pointed out that cotton does not show any injury when exposed to temperatures below 105 deg. C., but that at 115 deg. C. it begins to deteriorate, and above 125 degrees it rapidly disintegrates.

The reputation for efficiency of the New York telephone service has spread all over the world. In Paris the service has been so poor of late that the subscribers have organized to demand improvements. Quite recently the Ministère de Postes et des Telegraphes of France applied to the vice-president of the New York Telephone Company, asking if he would be willing to train six telephone officials from Paris in the various methods employed in New York. The request was gladly acceded to.

An office was recently opened in Chicago by the Telepost Company, which employs the Delany rapid telegraph system. As described some years ago in the Scientific American, a perforated paper tape is used, by which the signals are transmitted over the line at high speed. To avoid the overlapping of successive signals because of the line capacity, each signal is made up of a positive impulse followed by a negative impulse. At the receiving station the message is recorded on a chemically prepared tape.

A recent number of the Electric Railway Journal describes briefly a peculiar electric locomotive used for canal haulage near Bremen. The locomotive runs on a quay, which has to be kept clear for the passage of drays. In order to secure the requisite weight for adhesion, the locomotive is built in the form of two inverted U's connected at the top with a girder. The width of each base is only 28 inches, and so the driving motor had to be placed in the upper part of the structure. The locomotive thus straddles the traffic, and can travel up and down the quay without disturbing the trucks, which pass between the U's and under the connecting girder.

A special type of motor has been built for a British powder factory, in which precautions have been taken to render the motor flame-proof and explosion-proof. The motor case is very strongly built, so that it will stand explosion of dust or gases which might find their way into it. The joints of the motor case are packed with hemp rope dipped in tar, this being considered more durable than rubber at high temperatures. The bearings are also specially packed to prevent the escape of hot gas in case of explosion within the motor. No ventilation for the interior of the motor is provided, but the casing is formed with corrugations which furnish a large cooling surface.

In the discussion which followed the reading of a paper on underground conduit construction for large transmission systems before the American Institute of Electrical Engineers in Chicago, the following illustration was given to point out the advantages of concrete over tile because of its lower thermal conductivity and its better heat resistance. A burn-out occurred in a 1,000,000 circular mil 230-volt cable in the middle of a 9-duct outlet from a manhole. On examination it was found that the conductor had been completely consumed, but the concrete was burned to only a quarter of an inch while the cables in the ducts above and below showed not the slightest injury. Had tile been used instead of concrete, the heat developed would have been sufficient to damage the conduit very seriously.

The naval gun factory at Washington, D. C., is equipped with six cranes, four 60-ton cranes on the first track, a 110-ton crane on the next track above, and a 200-ton crane on the third track, which is 160 feet above the ground floor. The track is 500 feet long, running the full length of the gun factory. The shrink pit is located at one end of the shop, making it a difficult matter to call a certain crane. Accordingly an annunciator system has been installed on each crane with a push button for each crane located on a board close to the pit. These buttons are connected to the annunciator in the crane cab by light trolley wires strung along the web of the I-beam that supports the cranes. In this way either crane can be called by pushing the button. If the crane is busy the call will show on the annunciator.

The very first day of the inauguration of letter telegrams proved the success of this method of communication and gave promise of a great future. The principal business was done between the large commercial centers, such as New York, Boston, Chicago, St. Louis, and New Orleans. By this system a 50-word message may be sent at night at the price of the ordinary 10-word message. At the receiving end the message is deposited in the nearest post office for delivery by the first morning mail. Thus the wires are kept as busy at night as in the daytime. A great deal can be said in fifty words, so that quite a lengthy message can now be sent to distant points in less time and cost than formerly.

SCIENCE.

On March 6th Vesuvius suddenly became active again. There was a continuous eruption for twenty-four hours of red hot stones and ashes, accompanied by internal detonations. Several fissures opened, from which gas and lava emerged in great quantities.

Prof. Wilhelm Trabert has been appointed director of the Central Institute for Meteorology and Geodynamics at Vienna, succeeding the late Prof. Josef Maria Pernter. As director of this institution he is the official head of meteorology in Austria.

Dr. Felix Exner of Vienna has completed the great treatise on meteorological optics begun by the late Prof. J. M. Pernter in 1902, about two-thirds of which had been published up to the time of Pernter's death in 1908. It is the only extensive modern work on this subject.

The commission appointed to examine the Leaning Tower of Pisa has reported that it thinks its foundations may need strengthening. A spring exists under the tower, the water of which is raised by steam pumps for the use of a local factory. As the bed of the spring is emptied, it is feared, a subsidence of the ground on which the campanile stands will follow.

Dr. Herman C. Bumpus, director of the American Museum of Natural History, announces that up to last August, at least, V. Steffansson and R. M. Anderson, the museum's Arctic explorers, were safe. A letter from Mr. Steffansson, from Herschel Island, in the Arctic Ocean, dated August 19th, 1909, has been received, telling of the adventures and successes of the party.

The task which the American south polar expedition had set itself to perform, in the opinion of Sir Ernest Shackleton, was much harder than was generally recognized, inasmuch as no one had ever landed in the place where the exploring party purposed to land. Indeed, no one had ever seen land there, although there was an ice cliff 150 feet high which was called land. Still, Americans might find land in that locality.

Dr. Le Faguays recommends a process of disinfection which consists in blowing upon the contaminated surfaces a current of air heated to a very high temperature (600 to 900 deg. F.). This process may be applied not only within buildings, but also to the surface of streets, yards, etc. The apparatus is heated by petroleum and is very simple. This process not only destroys disease germs, but it is very efficacious against fleas and other vermin.

Kuhne has devised a process for the manufacture of sulphuric acid, based upon the employment of the ultra-violet rays emitted by mercury vapor lamps. A mixture of air and sulphurous acid gas is introduced into a tower, lined with lead, into which water is injected in fine jets. Under the influence of the ultra-violet radiation of lamps in the tower, the sulphurous acid is entirely converted into sulphuric acid. Several towers are connected together. The strength of the sulphuric acid solution obtained in the first tower can be increased by spraying it, instead of water, into the second tower. In like manner, the product of the second tower is sprayed into the third, and so on. In the last tower, however, pure water is again used as soon as any sulphurous acid appears in the escaping gases.

The Zeppelin North Polar Exploration Committee met recently under the Presidency of Prince Henry of Prussia. Count Zeppelin, Prof. Hergesell, and Prof. Lewald were among those present. The committee discussed the programme for the summer's work, which will be devoted to a preliminary expedition for the purpose of studying ice conditions. The government will be asked for the use of the exploring vessel "Poseidon" for about two months. The expedition will start for Spitzbergen July 1st on an excursion steamer, and there will transfer to the "Poseidon." A Norwegian ice steamer will be used for the purpose of forcing an entrance into the polar ice, and the expedition will return at the end of August. Apparently no airship will be taken for summer use.

For once the bacteriologists and hygienists, who usually appear to delight in alarming timid folk, announce a discovery which will reassure those persons who are afraid to eat green vegetables. Manau thought that he had discovered soil microbes in the interior of vegetable stalks. From this discovery resulted the condemnation of sewage farms and, indeed, of all market gardening as it is ordinarily practised, with the employment of manure. Fortunately this opinion has not been shared by all bacteriologists. In order to solve this problem, which is so important from the hygienic point of view, Remlinger and Nouri have undertaken a series of experiments, in which they endeavored, by every possible means, to infect plants with microbes. In every case, however, they found it impossible to obtain colonies of microbes from the interior parts of the plants thus infected. Hence they conclude that the microbes in the soil do not penetrate into the interior of plants, but remain entirely upon the surface.

NEW AEROPLANES AT HOME AND ABROAD.

THE "BADDECK NO. 2" AEROPLANE.

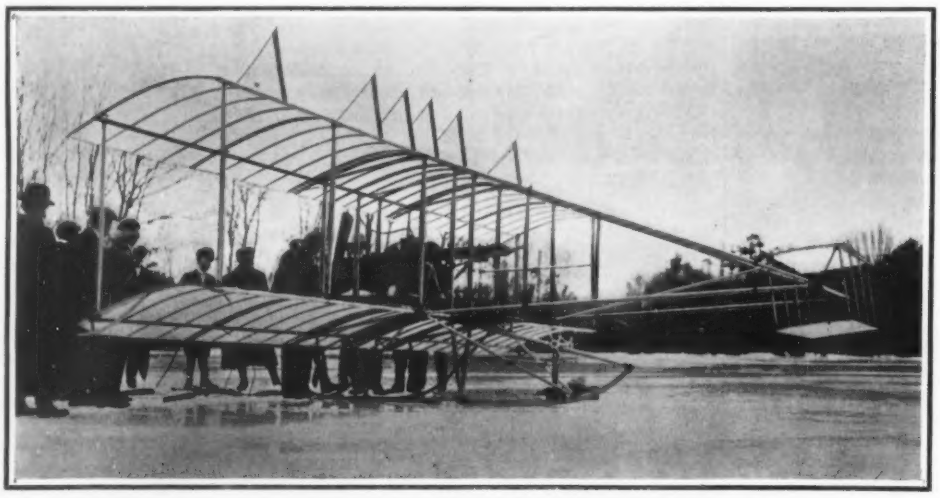
A noteworthy aeroplane so far as actual flying is concerned is the "Baddeck No. 2" of Messrs. McCurdy and Baldwin, who are still working with Dr. Bell near Baddeck, Nova Scotia. As our photographs show, this biplane is an excellent flyer. It has made a considerable number of more or less lengthy flights above the ice of Lake Bras d'Or, in a number of which passengers were taken.

The planes of the McCurdy and Baldwin machine are 40 feet long by 7 feet wide at the middle, decreasing to 5 feet at the ends. The wing tips, which are double and attached at each end of the main planes, are about 5 by 5 feet in size. They are hinged near their front edges, and rocked in the usual manner by means of a fork fitting around the aviator's shoulders. The horizontal rudder consists of two superposed surfaces spaced 30 inches apart, and mounted 15 feet in front of the front edge of the main surfaces. The surfaces of this rudder are 12 feet by 28 inches in size. A biplane tail is also used, the planes being the same size as those which form the front rudder. This tail is mounted 11 feet from the rear edge of the main planes. The horizontal and vertical rudders are operated by a wheel in the same way as on the Curtiss biplane. In other words, a push forward or a pull backward on the wheel directs the machine downward or upward. Turning the wheel to the right or left steers the machine sideways.

The motive power of this biplane is a 6-cylinder Kirkham automobile motor of 40 horse-power. It is water cooled and develops its rated power at 1,400 R.P.M.; at 2,000 R.P.M. it develops 48 horse-power. The radiator is novel, consisting of thirty flattened tubes 7½ feet long by 3 inches wide by 3/32 inch thick. These tubes are curved from front to rear in the same manner as the main planes, and sufficient lift is obtained to support the weight of the radiator and water carried. The motor is geared to a single 7-foot 8-inch propeller having a 6-foot pitch, by means of a chain, the ratio being 3 to 5. The thrust obtained is sufficient to drive the machine at a speed of over 40 miles an hour.

The chief features of Messrs. McCurdy and Baldwin's biplane are the use of a comparatively heavy 6-cylinder automobile motor, and the fitting to the machine of a biplane tail of the same shape and size as the horizontal rudder. The 6-cylinder motor has been found superior to the 4-cylinder for automobile work, but this is the first aeroplane, so far as we know, to be fitted with this type of motor. The motor is placed low down upon the lower plane, in order to keep the center of gravity low, while the propeller is mounted higher up, so that the center of thrust shall be as near as possible to the center of resistance of the aeroplane. The usual three-wheel chassis, first used by the Aerial Experiment Association, of which Messrs. McCurdy and Baldwin were members, is fitted to the machine.

After making numerous satisfactory flights above the frozen surface of the lake, Messrs. Baldwin and McCurdy were visited on the 9th instant by Major Munzell of Ottawa, who represented the military department of Canada. The two inventors made five exhibition flights for this officer, and finally he consented to make a flight as passenger with Mr. McCurdy. A very satisfactory flight of several minutes' duration was made. Messrs. McCurdy and Baldwin made a number of flights last summer and fall in Canada, and the Canadian government is very much interested in their machine, and will doubtless eventually purchase one for military use. The noteworthy point about this machine is that its makers have built it sufficiently large to carry a weighty and reliable motor, and there is little doubt that the machine is capable of making extended flights without difficulty.



The Herring Biplane, showing novel stabilizing fins.

This new biplane has several new features, such as foot operation of the horizontal rudder, fins for automatic transverse stability, a skid instead of wheels, etc.

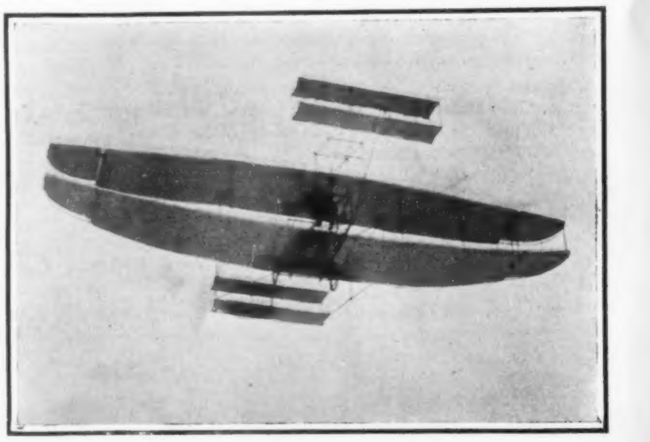
THE NEW HERRING BIPLANE.

The best constructed aeroplane on exhibition at the Boston show, as noted in previous issues of this journal, was the new biplane of A. M. Herring. The photograph of this machine, reproduced above, was taken at the time of the trial flight on March 1st, and it gives a very good idea of the biplane's novel features. The spread of the planes is about 28 feet, and the fore-and-aft width about 4 feet, the total supporting surface being 220 square feet. A 25-horse-power Curtiss motor is mounted upon the lower plane at the rear, and carries upon its crankshaft a 4-bladed 6-foot propeller of 5-foot pitch, designed by Mr. Herring. The total

(*Continued on page 246.*)

Capt. Baldwin's novel biplane.

The rudder above the upper plane is worked by a fork fitting about the aviator's shoulders. It corrects the side-tipping of the aeroplane.

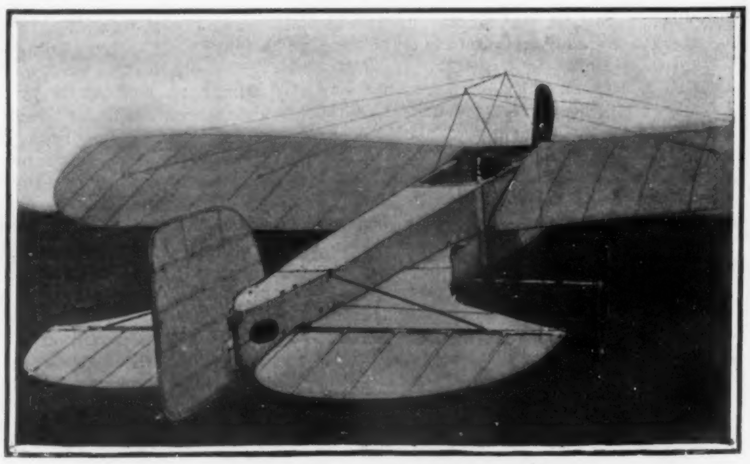


Messrs. McCurdy and Baldwin flying in their "Baddeck No. 2" biplane.

This is the first aeroplane to be equipped with a six-cylinder automobile motor. It has made many successful flights in Canada.

Sir Hiram Maxim standing behind his new biplane.

This machine is similar in many respects to the inventor's gigantic aeroplane built nearly 20 years ago.



Rear view of Bleriot XI. *bis* monoplane, showing the new tail.

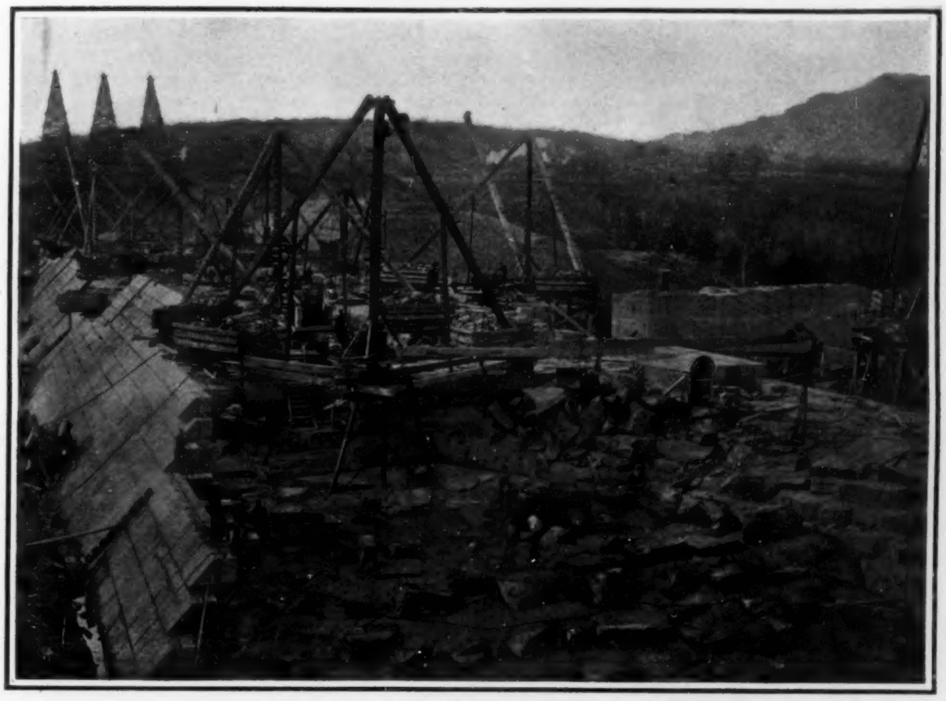
Note the complete covering of the body, and the large horizontal rudder at the rear end of the tail.

NEW AEROPLANES AT HOME AND ABROAD.

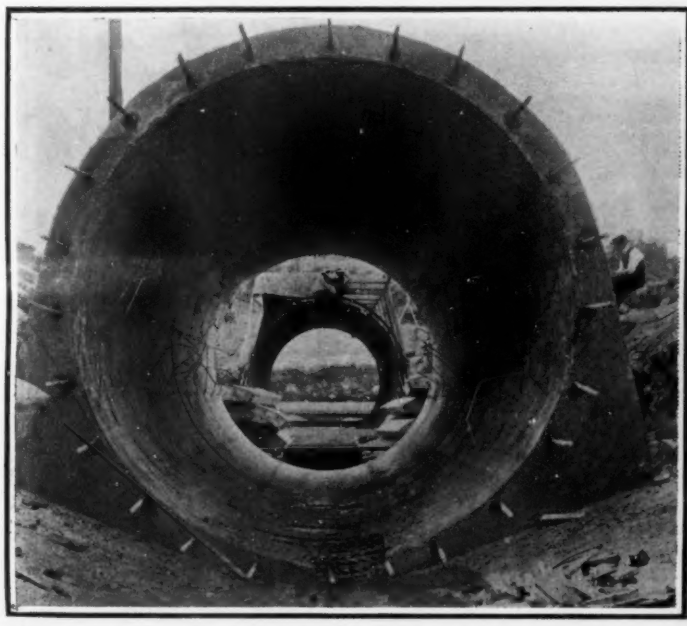
BUILDING THE OLIVE BRIDGE DAM FOR THE CATSKILL WATER SUPPLY.

Work on the Catskill water supply, which will provide New York with five hundred million gallons of water daily, is making steady progress, as will be evident from the illustrations of this work which are herewith presented. Briefly stated, the scheme consists of the construction of a large reservoir in the Esopus watershed in the Catskills, with a storage capacity of 127 billion gallons and an aqueduct 92½ miles in length for conveying the water to the New York city line. The Ashokan reservoir, as it is called, will supply the city with 250 million gallons daily in addition to the 375 million gallons now available in the reservoirs of the Croton watershed. As the future needs of the city demand it, reservoirs will be built in the Rondout and Schoharie watersheds adjoining the Esopus Valley, and from these three dams it will be possible to draw sufficient water for the full capacity of 500 million gallons daily of the new aqueduct. The latter passes through the Croton watershed and in two years time, and before the full completion of the Ashokan reservoir, a portion of the water stored therein will be available for delivery through the new aqueduct to the new Croton dam. The work is to be completed by February, 1915.

The Olive Bridge dam, which will create the Ashokan reservoir, is a huge structure with a maximum height from the lowest foundation of 240 feet and a width along the crest of 4,830 feet. The central portion immediately above the river is built of cyclopean masonry, and extends for 1,000



Present condition of Olive Bridge dam as viewed from north bank.



A completed section of the 92½-mile steel-and-concrete aqueduct.

Upstream side of Olive Bridge dam, diversion tunnel for carrying river during construction.

Site of dam, showing the 8-foot pipes for passing river through the work.

Placing steel reinforcement for the concrete aqueduct.

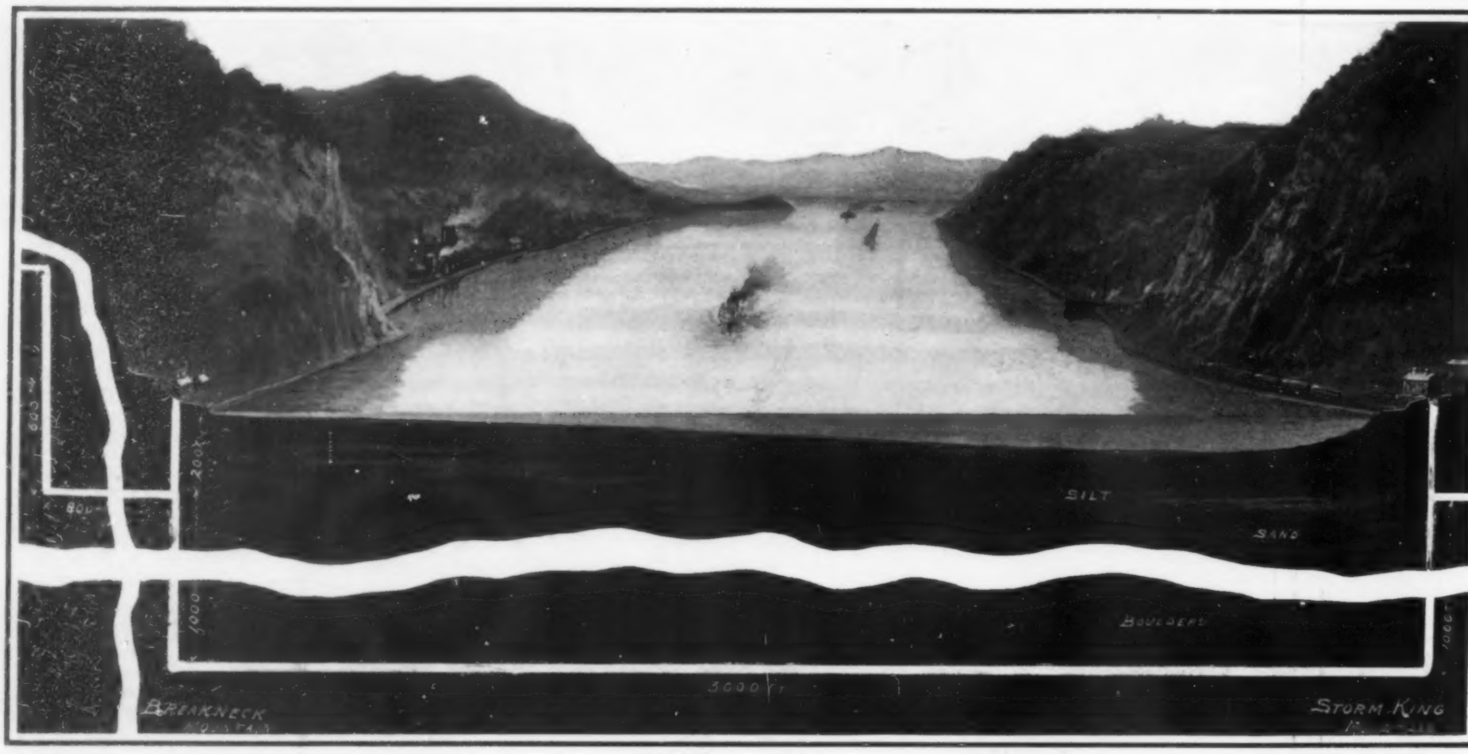
BUILDING THE OLIVE BRIDGE DAM FOR THE CATSKILL WATER SUPPLY.

feet in width. The rest of the dam consists of a central masonry core wall and carefully laid and rolled earth. In addition to the main dam there are two series of embankments known as the Beaver Kill and Hurley dikes, the former extending for 13,144 feet and the latter for 2,200 feet. In addition to these works there is a waste weir 1,100 feet in length and a dividing dike and weir 2,200 feet long. Taken altogether, the masonry and earthworks necessary to close the valley depressions and raise the water to the desired height measure five and one-half miles in aggregate length.

had been reached, a large culvert, 35 feet wide by 40 feet high, of sufficient size to take care of any possible floods coming down the valley, was formed in the wall of the dam. As soon as the vertical walls had been carried up a sufficient height to accommodate the river, the latter was diverted through the culvert and the 8-foot pipes were removed. Some interesting work was done in building the roof of the tunnel, a series of framed steel brackets or cantilevers being placed on each side of the opening, from which the wooden forms for the arch of the tunnel were suspended. Then, as the masonry was laid, a series of

above mean sea level. Its thickness will be 26 feet at the crest, its maximum thickness at the base about 200 feet, and the masonry work will contain 550,000 cubic yards of material. The maximum width of the earth-and-core-wall wings of the dam will be about 800 feet; their top width, about 34 feet; and the total quantity of embankment will be about 2,000,000 cubic yards. The elevation of the discharge will be 590 feet above tide level.

The Beaver Kill dikes, which have a total length of about 2.3 miles, will have a maximum height of about 110 feet above the original surface, and they will con-



Cross-section of the Hudson River near Cornwall, showing how the Catskill water supply will be carried under the river in a pressure tunnel in the solid rock 1,200 feet below tide level.

The accompanying photographs, for which we are indebted to the MacArthur Brothers Company, who have contracted to build the main dams of the Ashokan reservoir for over twelve and a half million dollars, serve to illustrate the character of the work. The earliest of the operations consisted in providing a bypass in the form of two 8-foot steel pipes for carrying the flow of the Esopus Creek past the dam during the work of excavation, and the construction of the masonry up to the level of the river. When this level

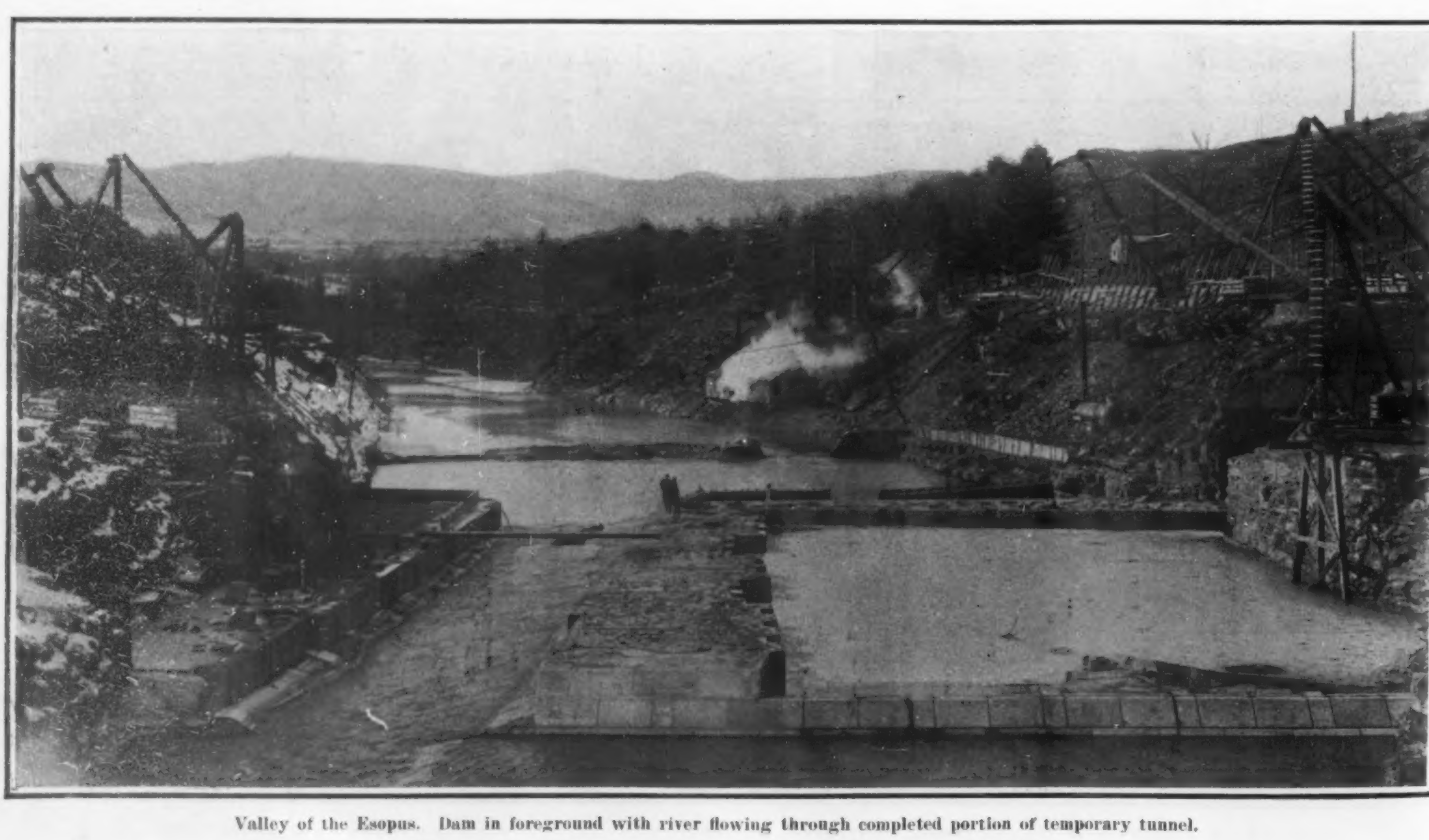
heavy steel I-beams were placed transversely to the axis of the tunnel, from which the forms with their super-incumbent load of masonry were suspended by vertical tie-rods. To facilitate the flow of the water, the wooden forms will be left in place until the dam is completed. Then the flow will be diverted, and the tunnel will be filled in with masonry. When this is completed, the filling of the reservoir will take place.

The top of the Olive Bridge dam will be 610 feet

tain about 5,000,000 cubic yards. Like the earthen portions of the Olive Bridge dam, they will be built with a concrete core wall. The reservoir will be divided by a dike into two basins. This dike will have a length of 1,100 feet, and the dividing weir will have the same length.

It will be readily seen from these figures that the Ashokan works are on an immense scale. They involve over 2,000,000 cubic yards of earth and 425,000

(Continued on page 249.)



Valley of the Esopus. Dam in foreground with river flowing through completed portion of temporary tunnel.

BUILDING THE OLIVE BRIDGE DAM FOR THE CATSKILL WATER SUPPLY.

An Important German Patent Decision.

A very important case was recently decided by the Supreme Court of the German Empire, First Civil Senate, in which the rights of American patentees in Germany are defined. The facts in the case are briefly these:

The National Cash Register Company of Berlin, a limited liability company, incorporated under the German law, is the owner of three German patents. In Germany the patentee must work an invention within three years from the date of publication. That term had expired for all four patents. Proceedings were instituted by Schubert & Salzer Machine Works in the Imperial Patent Office to revoke these patents on the ground that they had not been worked to an adequate extent in Germany, and that in all their essential parts the cash registers protected by the patents were manufactured by the National Cash Register Company of Dayton, Ohio, and were imported from the United States into Germany. In its defense the National Cash Register Company of Berlin stated that one German patent had been worked in Berlin, and that this patent was in substantial agreement with the American patent covering the identical points of invention; that the other three patents were not worked in the German Empire, but that their revocation would not serve any public interest. The Imperial Patent Office revoked all four patents, arguing that the one patent which was worked in Germany was not identical with the American patent cited by the defendant.

The National Cash Register Company appealed from the decision of the German Patent Office on the ground that the German Patent Office erred in holding that the German patent alleged to be identical with the American patent was not worked in Germany, and still setting up the old defense that the revocation of the remaining three patents would not further public interest. Pending the appeal, the National Cash Register Company of Berlin changed its firm name so that it read National-Registrierkassen-Gesellschaft mit beschraenkter Haftung. All four patents were assigned by this new company to the National Cash Register Company of Dayton, Ohio, so that the patents no longer belonged to a German but to an American firm. Pending the appeal, one patent became void for failure to pay the annual tax, and another patent was abandoned. There remained for consideration the validity of the German patent which was worked and which was alleged to be identical with the American patent, and another German patent which was not worked. The National Cash Register Company of Dayton, Ohio, on petition was permitted to interplead as a party to the suit in place of the German company because it was the assigner of the patent rights.

The first question which came up before the court was whether the American company could be permitted to act as the defendant on appeal in view of the fact that the German company had been the defendant when the action was brought before the German Patent Office. The point depended upon an interpretation of Section 265 of the German Civil Code. The Supreme Court decided that it was not a violation of that section of the Civil Code to substitute the American company for the German company as defendant. The forfeiture of the patents involved a consideration of the treaty of February 23rd, 1909, between the German Empire and the United States of America relating to the mutual protection of industrial property. That treaty became a German law on August 1st, 1909, and affected the patents which had been assigned to the American company. The treaty provided in substance that the American patents of Germans and the German patents of Americans were to be restricted in their respective countries only so far as they were restricted by the opposite contracting party's laws. The German patent law compels the working of patents in the German Empire on pain of forfeiture within three years. On the other hand, there is no law in the United States to compel the working of patents. The court therefore holds that the treaty exempts American citizens from the obligation of working their German patents in Germany because German citizens are not compelled to work their American patents in the United States. Hence, because the patents for which forfeiture was demanded were the property of an American company, the decision of the German Patent Office was reversed.

As a result of this very important decision, an American citizen stands in a better position before the German courts, so far as forfeiture is concerned, than a German subject. It is usually the object of a treaty to secure equal rights to the contracting parties, but in this case it would seem that a very liberal interpretation of the treaty gives to American citizens probably more than they originally bargained for.

The Current Supplement.

The opening article of the current SUPPLEMENT, No. 1785, is by L. A. Bauer, Director of the Department of Research in Terrestrial Magnetism, in which he describes the instruments and methods of the ocean magnetic work of the Carnegie Institution of Washington. The article is elaborately illustrated. Extracts from affidavits submitted in the case of Wright vs. Paulhan, as well as Judge Hand's decision, are given. In this decision the Farman, Blériot, and Wright machines are considered from the patent lawyer's standpoint. The Berlin correspondent of the SCIENTIFIC AMERICAN writes a fascinating article on the number of particles projected by cathodes. It seems almost incredible that invisible particles smaller even than atoms can be counted, and yet in this article the method of so doing is described. Prof. K. Svehla points out the disinfecting qualities of a sad-iron. The powerful passenger and freight locomotives of the Mallet type recently built for the Atchison, Topeka and Santa Fe Railway are described. W. P. Dreaper's article on the artificial silk industry is continued. P. H. Cowell writes on Halley's comet as seen from the earth. He gives a table of ecliptic coordinates in two decimal places at intervals of four days through an arc extending from one end to the other of the *latus rectum* of its orbit, as well as a diagram giving the position of the earth for six days in May; also the position of the comet on twenty-seven days measured from perihelion passage in days. Some novel toys are described and illustrated.

A German Antarctic Expedition.

A German south polar expedition has been virtually arranged by Lieut. Filchner of the General Staff, under the auspices of the Geographical Society. Lieut. Filchner announced at a meeting of the society that the expedition would start in October of this year if the necessary funds were forthcoming.

The plan is to send a vessel with provisions over the route followed by Lieut. Shackleton and form a depot at about the half-way point to Shackleton's winter headquarters. The regular expedition would start later from Weddell Land on the opposite side of the pole and make a dash across with the depot as objective.

Dr. Penck, chairman of the Geographical Society, announced that an anonymous donor had given $75,000 toward defraying the cost of the expedition, and Lieut. Filchner had promises of a further $15,000. It was hoped, he said, that they would be able to send out two vessels in order to save time.

Lieut. Filchner is an explorer of experience. He was one of the first to reach Lhassa, Tibet, and in 1903 and 1905 he explored Turkestan and Persia.

The Life of Radium.

An interesting and informative popular lecture upon the wonders of radium was recently delivered before the members of the Authors' Club in London by Sir William Ramsay, K.C.B. In describing the wonders of this element, the eminent chemist confined himself mainly to a description of his own investigations and experiments. In dealing with the Alpha particles, he explained that these were really gas, and quite two-thirds of the energy of radium was transferred to the gas which it emitted, which comes off at a regular rate, and this he pointed out raised the question as to how long radium would last. He replied for ever, as the amount of gas was always proportionate to the amount of radium present. He likened this emission of gas to taking a slice of bread and cutting it in two, which operation say occupied a minute, and then cutting one-half in two again, and so on continually cutting in two each successive half obtained. How long would it take him to cut the bread entirely up? He could never do it. He would always be halving to infinity, and the task would take him an eternity to perform. It was exactly the same with radium. The amount of gas was always proportionate to the mass of radium existing and was always being produced. There was however, he remarked, one point easily defined. When would radium be half gone? They had just measured it in his (Sir William's) laboratory and had found that it would take 1,750 years, so that anyone who invested in radium would retain at least one-half of the capital at the end of 1,750 years. The Austrian government some time ago intrusted him with about half a gramme or one fifty-fifth part of an ounce of radium for his private use. Its value was about $45,000. Less than a year ago Dr. Gray and himself performed the experiment of isolating the Alpha emanation of radium, and they inclosed it in a fine glass tube, much finer than the finest thermometer tube that was ever made. They compressed it and liquefied it. In the latter stage it shone with a purplish light, although it was quite transparent like water. When reduced to a temperature of —60 deg. Cent. it solidified, and then it shone with an extremely brilliant light like a miniature electric arc light. The quantity they used was extremely small, being less than the point of the finest needle, yet they ascertained its boiling point, its melting point, and its specific gravity.

Radium was the most concentrated form of energy known. It is a substance which goes on changing into other things to which various names have been given. These substances were named radium A, radium B, radium C, and so on up to radium F. Some had a very brief existence, lasting only thirty or forty minutes, and he had never seen them. He had seen radium D, which would be gone in about forty years. This was a substance rather dull looking, like lead, and that was nearly all he could say about it. There were other substances probably like polonium which Madame Curie discovered. During these emanations radium gave a great deal of energy, generally manifested as light, but as a matter of fact radium kept itself hot; there was a great deal of heat generated. It could be calculated, and it was found that it gave off about 3,500,000 times as much heat as would be given off by the oxyhydrogen blowpipe, which gave a temperature of over 2,000 deg. Cent.

What did this energy do? It sent out the Alpha rays at a velocity of about 40,000 miles per second, and these particles naturally carried a great deal of energy. The Beta rays, although only about one-thousandth part of the size, also carried tremendous energy, owing to their enormous velocity, which exceeded that of the Alpha rays. They could decompose water and metallic substances, and in these decompositions they found elements produced which they did not imagine to exist in the substances so treated. For instance, in decomposing ordinary copper sulphate they were surprised to discover lithium in what remained, and no traces of the copper salt. He had repeated this experiment five times, and the experiments were still going on.

Ephemeris of Halley's Comet.

1910.	R. A. h. m. s.	Declination. ° ′	Log. r.	Log. Δ
April 4	0 5 38	+ 8 1	9.8369	0.2144
April 8	0 1 43	7 58	9.8101	0.1910
April 12	23 57 58	7 53	9.7883	0.1617
April 16	54 24	7 49	9.7738	9.1257
April 20	51 44	7 46	9.7688	0.0808
April 24	50 20	7 47	9.7757	0.0272
April 28	50 33	7 56	9.7911	9.9609
May 2	23 54 32	8 18	9.8146	9.8796
May 6	0 3 6	9 5	9.8363	9.7779
May 10	21 35	10 30	9.8654	9.6437
May 11	29 33	11 2		9.6049
May 12	38 32	11 41		9.5609
May 13	0 50 12	12 29	9.8877	9.5134
May 14	1 5 47	13 27		9.4618
May 15	1 24 47	14 36		0.4086
May 16	1 49 52	15 59		9.3501
May 17	2 23 4	17 29	9.9176	9.2945
May 18	3 7 19	18 51		9.2388
May 19	4 3 11	19 43		9.1993
May 20	5 3 23	19 8		9.1873
May 21	6 9 54	17 40	9.9468	9.1993
May 22	7 3 4	15 14		9.2388
May 23	7 44 48	12 40		9.2921
May 24	8 18 20	10 24		9.3480
May 25	40 7	8 31	9.9751	9.4049
May 26	8 58 52	6 59		9.4601
May 27	9 13 8	5 45		9.5120
May 28	24 36	4 45		9.5583
May 29	33 48	3 50	0.0049	9.6037
May 30	9 41 23	+ 3 15		9.6405

Astronomische Nachrichten, No. 4379. A. C. D. Crommelin.

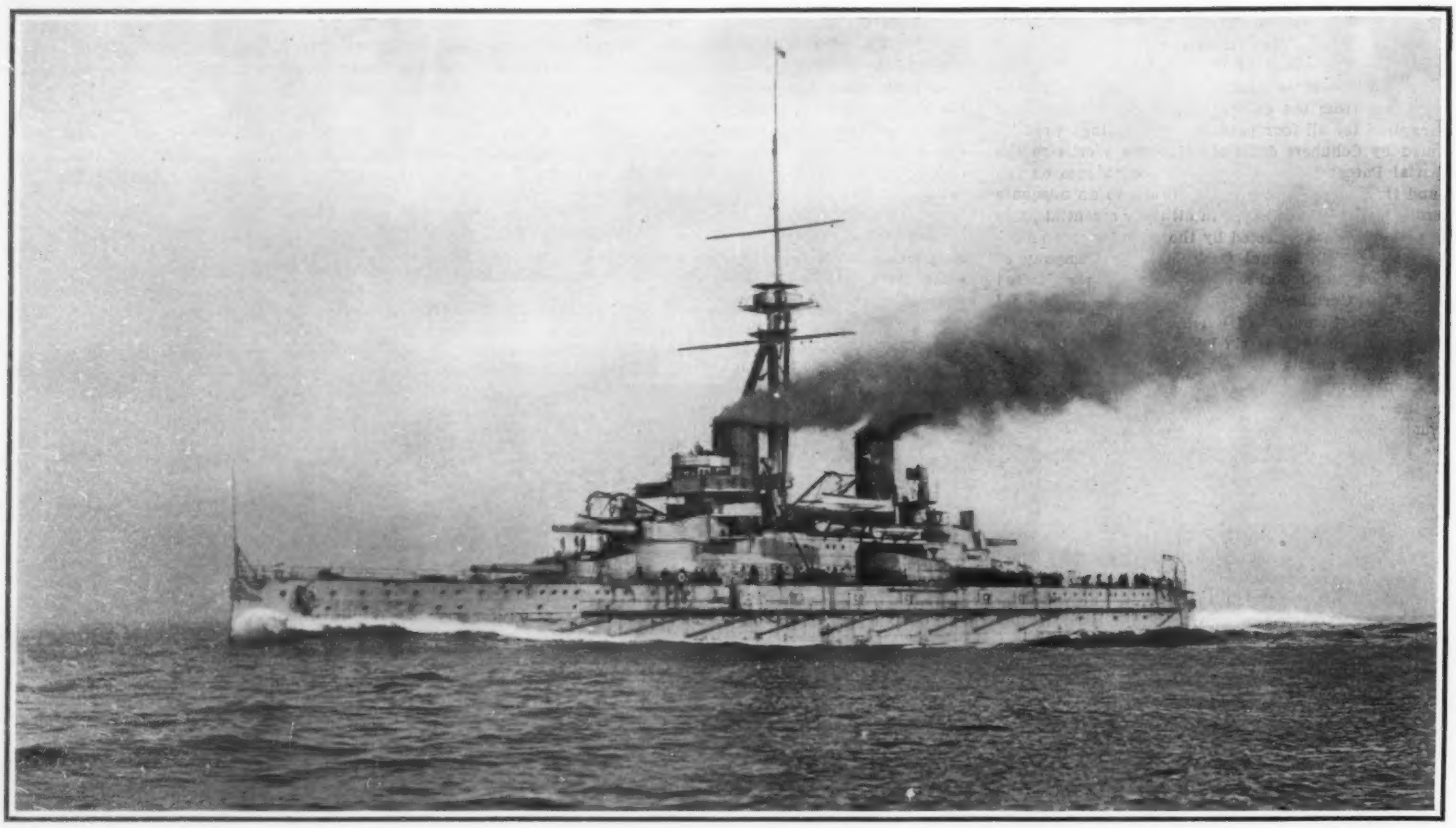
Prizes for Small Aeroplanes.

The practical utilization of the aeroplane is the object toward which the efforts of all constructors and experimenters are directed. In furtherance of the same object, the French National Aerial League offers two prizes for small and easily managed aeroplanes. One prize, offered by M. René Arnoux, through the agency of the League, will be awarded to the first aviator who shall succeed in starting from a selected road, bordered with trees, and in landing on the same road after making a continuous flight of one kilometer (⅝ mile) or more. The other prize, of 1,000 francs (about $200), will be awarded to the owner of the smallest aeroplane which shall make a continuous circuit of one kilometer. The size of the aeroplane will be estimated by multiplying together the three maximum dimensions of the machine. The competition will close July 16th, 1910. A complete copy of the rules governing the competition can be obtained by addressing La Ligue Nationale Aérienne, 27 Rue de Rome, Paris.

The number of bacteria contained in milk increases very rapidly from the moment of milking for a certain time, and then slowly decreases. Some bacteriologists have attributed this phenomenon to a bactericidal power possessed by the milk due to some unidentified ingredient. Experiments have been made to isolate this hypothetical substance, which appears to remain active up to a temperature of 140 deg. F. The milk was filtered through a porcelain cylinder, and the filtrate obtained showed greater germicidal power than ordinary milk, but no conclusive results were obtained. The real explanation of the germicidal power of milk is much simpler. The acidity of milk continually increases with age and thus milk continually becomes a less favorable medium for the growth of bacteria. The bacteria also have to contend with the lactic ferments, which develop very rapidly in sour milk, and are generally victorious in the struggle for existence. It is for this reason that the lactic ferments are employed in therapeutics.

THE BRAZILIAN BATTLESHIP "MINAS GERAES."

In the early part of this year the first of the dreadnought battleships, the "Minas Geraes," about which much speculation has been rife, was handed over by the builders, Sir W. G. Armstrong, Whitworth & Co., of Elswick, Newcastle-on-Tyne, to the Brazilian government, thus definitely disposing of the supposition that the vessel was designed for some other power. This vessel has been the source of considerable discussion, since it represents the last word in heavy battleship design, and is at present the most powerfully armed warship afloat. Through the courtesy of Admiral Maurity, the president of the Brazilian naval commission in England, appointed by the government of the South American state to supervise construction,



Length, 543 feet. **Breadth,** 83 feet. **Normal displacement,** light, 19,000 tons. **Horse-power,** 27,212. **Speed,** 21.4 knots. **Armor:** Belt, 9-inch, extending for full height of hull; turrets, 9-inch; two protective decks, 1¼-inch and 2-inch. **Armament:** Twelve 45-caliber 12-inch; twenty-two 4.7-inch. Four torpedo tubes.

THE BRAZILIAN DREADNOUGHT "MINAS GERAES."

During the gun trials of the "Minas Geraes" ten 12-inch guns were trained on the broadside and discharged simultaneously. The combined energy of the projectiles amounted to 500,000 foot-tons, or sufficient to lift the ship bodily 26 feet into the air.

THE GREATEST BROADSIDE EVER FIRED FROM A BATTLESHIP.

we are enabled to publish the accompanying photographs and to give the leading particulars regarding this, the latest dreadnought.

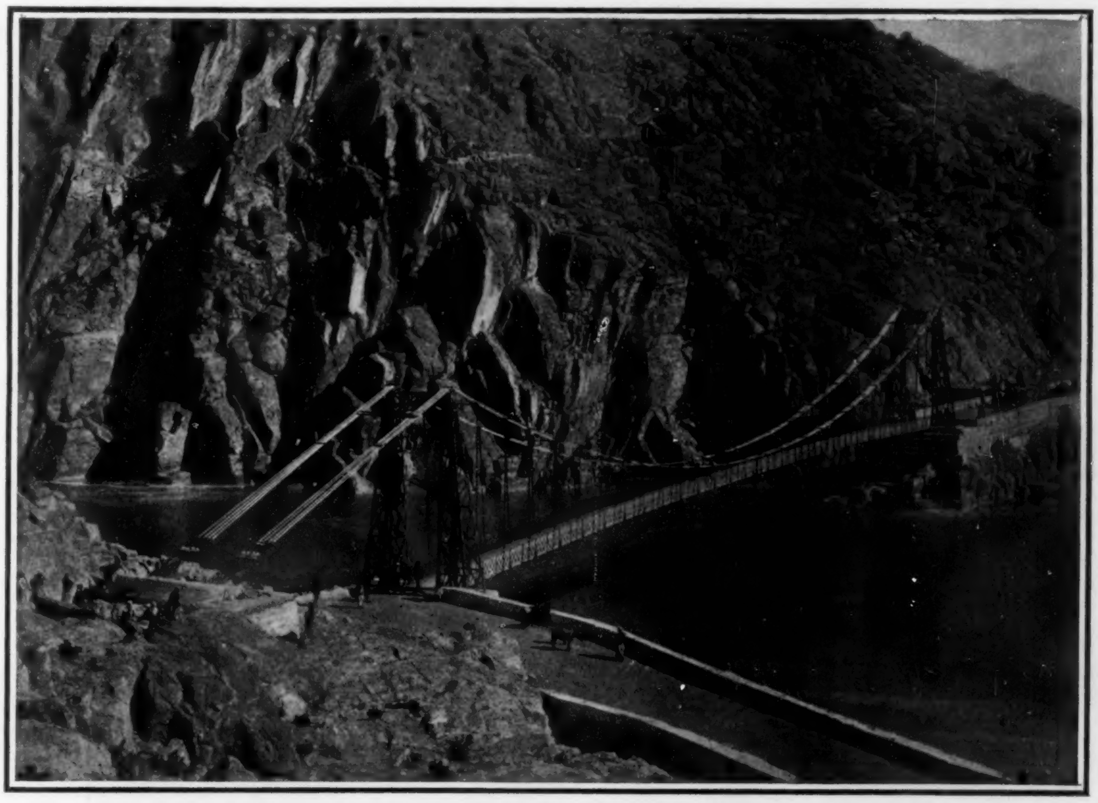
The general appearance of the vessel may be gathered from the accompanying illustration. The overall length is 543 feet, molded breadth 83 feet, molded depth 42.25 feet, displacement 19,000 tons, speed 21 knots. The propelling machinery, built by Vickers Sons & Maxim, who have the second vessel of the series completing at Barrow, is of the reciprocating four-cylinder triple-expansion type, driving twin three-bladed propellers. The cylinders have a diameter of 39 inches for the high-pressure, 63 inches for the intermediate, and 73 inches for the low-pressure, with a common stroke of 42 inches, and on the forced draft trial at 280 pounds pressure developed 27,212 indicated horse-power, giving a speed of 21.4 knots.

The outstanding feature of the vessel, however, is the armament. The main armor on the broadside amidships is 9 inches for a depth of 22.3 feet, 5 feet of which extends below the normal load water-line. The forward and aft barbettes are protected by a transverse 9-inch armor bulkhead, while forward and aft the hull is protected by 6-inch belt armoring tapering to 4 inches at the extreme ends. There are two protective decks, the upper being 1.25 inches thick, and the water-line deck 2 inches thick. Nine-inch armor is also used for the upper strake amidships, and the 4.7-inch guns of the secondary armament are mounted within the citadel thus formed. In regard to offensive armament, the main battery comprises twelve 12-inch 45-caliber guns. Four are carried in pairs in two turrets in the center line of the ship, both forward and aft, the remaining two pairs being mounted on either side amidships. In order to permit these to be trained throughout a full arc of 180 degrees, the superstructure is cut away fore and aft. It will be readily seen that the upper deck of the vessel is left clear of all obstruction, a factor which is one of the outstanding features of the design. It will be seen also that the pairs of guns forward, as well as those aft, are stepped, the uppermost pair being some 12 feet above the level of those below, so as to enable the upper to fire over the lower pair. It will be seen from this arrangement that a terrific gun fire can be concentrated on either side, for the forward and aft two pairs of guns can be trained through an arc of 150 degrees on either side of the center line of the ship, thus giving a fire from either broadside, including the pair of guns amidships of ten 12-inch guns. Moreover, owing to a pair of guns fore and aft being set at a higher elevation, they have a corresponding advantage in action. As these guns fire a projectile weighing 850 pounds, this means that an aggregate discharge of 8,500 pounds can be concentrated from either broadside. In the accompanying photograph taken during the gun trials a full broadside fire is shown, and this is interesting, as it is the first occasion on which ten 12-inch guns have been fired from a broadside. Similarly owing to the amidship guns on either broadside being capable of training through an arc of 180 degrees, it is possible to fire eight 12-inch guns ahead or astern.

The secondary armament comprises 4.7-inch guns and 3 pounders of the quick-firing type. The central superstructure of the vessel has been so designed as to carry four 4.7-inch weapons arranged in pairs one above the other on either side of the bridge at the forward end, with a similar disposition aft. These guns fire forward and aft parallel with the center line of the ship, but have a considerable angle of fire abaft the beam. Also six 3-pounders are similarly mounted forward and aft in the same superstructure, while two other 3-pounders are carried on the top of each of the gun houses of the upper level pair of guns. On the main deck there are seven 4.7-inch guns mounted within the citadel of 9-inch armor on either side, and the arrangement is such that the guns can be trained through an arc of 50 degrees on either side of the center line transverse to the keel, so that they can be trained astern and ahead. Altogether there are twenty-two 4.7-inch guns included in the secondary armament. The result is that in action the vessel can pour a broadside from ten 12-inch guns firing 850-pound shells, eleven 4.7-inch guns firing 45-pound shells, and six guns firing 3-pounder projectiles. As all are of the latest quick-firing type, a comprehensive idea of the formidable character of the attack of this vessel may be obtained.

The gun-operating mechanism is electrically and hydraulically driven, electricity being used for training the turrets. In addition there is emergency gear for every operation. Immediately the gun is fired an air blast cleans it, and the rammer is fitted with a water spray, so that in the event of any sparks remaining when the breech is opened, they may be at once extinguished. The accommodation for the personnel is most adequate and commodious, especially in regard to the officers' accommodation; and in view of the hot climate in which the vessel is to be in service, special attention has been devoted to ventilation. The navigating bridge has outer wings, which are also removed when the ship is cleared for action.

The gunnery trials created unusual interest, and the representatives of several powers were present thereat. The trials served to dissipate conclusively many apprehensions that had formerly been entertained. For instance, there was considerable discussion as to what effect would be produced upon the gun crew in the lower barbette of the fore and aft 12-inch guns when the weapons immediately above were discharged. In the first test the crew were withdrawn from the lower gun house when the upper pair was fired. It was found, however, that the roof of the lower house offered a complete protection against the blast, and that the crew could safely stay in the lower house without experiencing the slightest ill effects of the tremendous blast some five feet above their heads. It was also considered that the principle of setting the fore and aft guns one above the other and at a distance of 36 feet center to center was objectionable, on the plea that the aiming of the upper guns would be interfered with by the flash from the guns just below, but here again practical trials dispersed any such objections. These results, by the way, corroborate certain results obtained some years ago by our own Navy Department at Indian Head, when this system of mounting, first proposed and adopted in our "Michigan" and "South Carolina," was tested.



This graceful structure, recently completed, takes the place of a primitive rope ferry.

THE FIRST METAL BRIDGE TO BE ERECTED IN AFGHANISTAN.

Cement for Aquaria.—Equal parts flowers of sulphur, pulverized sal ammoniac and iron filings, mixed with good linseed oil varnish and adding enough white lead to make a solid, easily workable mass.

THE FIRST METAL BRIDGE IN AFGHANISTAN.

The accompanying illustration represents the Diroontah suspension bridge, the first metal bridge to be erected in Afghanistan, which was opened last year. The structure spans the Kabul River at the mouth of the famous Diroontah Gorge, about seven miles from Jallabad. Prior to the erection of the bridge communication was maintained between India and the adjacent country by means of a primitive native ferryboat, or raft, composed of skins stretched taut on a framework of rough timbers, and lashed together by means of crude native-made rope. A cable was stretched across the river, and when the latter was at its normal stage the raft was pulled from one bank to the other by this means. When, however, the waterway was in flood, and the turbulence and velocity of the current prevented recourse to the rope, the raft had to be rowed across the river, an operation which required considerable dexterity with the primitive oars used. The journey was somewhat dangerous under the circumstances, and the opposite bank was only gained some considerable distance downstream. Owing to the rude character of the ferryboat a capsize was by no means infrequent, and indeed several lives were lost from this cause every year.

When it was decided to erect a bridge, the site chosen for the structure was just off the old Kabul road. As the photograph shows, the gorge is extremely wild at this point, the rocky cliffs dropping straight down into the water. The contract was carried out under Mr. J. R. Halliday by the Calcutta engineering firm of Messrs. Burn and Company, Limited.

The bridge has a span of 396 feet between tower centers, with a clear width between parapets of 10 feet. It is designed for pedestrian and light vehicular traffic. The inaccessible character of the site combined with the fact that none but unskilled native labor was available, rendered the task somewhat difficult. The abutments had to be blasted out of the solid rock, as did the roadway approaches on either side. On the Jallabad side these preparations together with the setting of the foundation bolts were completed in seven and a half weeks. Work then had to be suspended for seven months, as the services of the Afghan labor was required in Kabul. Upon resuming operations, work was continued without further intermission, and the bridge was erected in the actual working time of five months. Considering the nature of the work, and that the native laborers were quite unacquainted with the tools used, such a performance was highly creditable. A further month however was occupied in blasting out a roadway and approach to the bridge in the cliff face on the Lagna side of the river. The bridge was opened by His Majesty the Amir of Afghanistan amid much ceremony and before a huge crowd of natives, who lined the precipitous hillsides to witness the novel spectacle.

Until a few years ago, all public coal lands were valued uniformly at a rate of $20 or $10 an acre, according if they lie less or more than 15 miles from a railroad. Since July, 1906, the government has been appraising its coal land according to the value of its contained coal. The present value fixed for the government coal land, based on the new regulation, is $149,772,443; the value fixed for these same coal lands before the new classification was adopted was $48,240,971. According to these figures, it is evident, therefore, that if these lands had been sold at the prices prevailing before July, 1906, they would have brought the government about $100,000,000 less than their value at the prices now fixed.

BIRDS AS MECHANISMS.

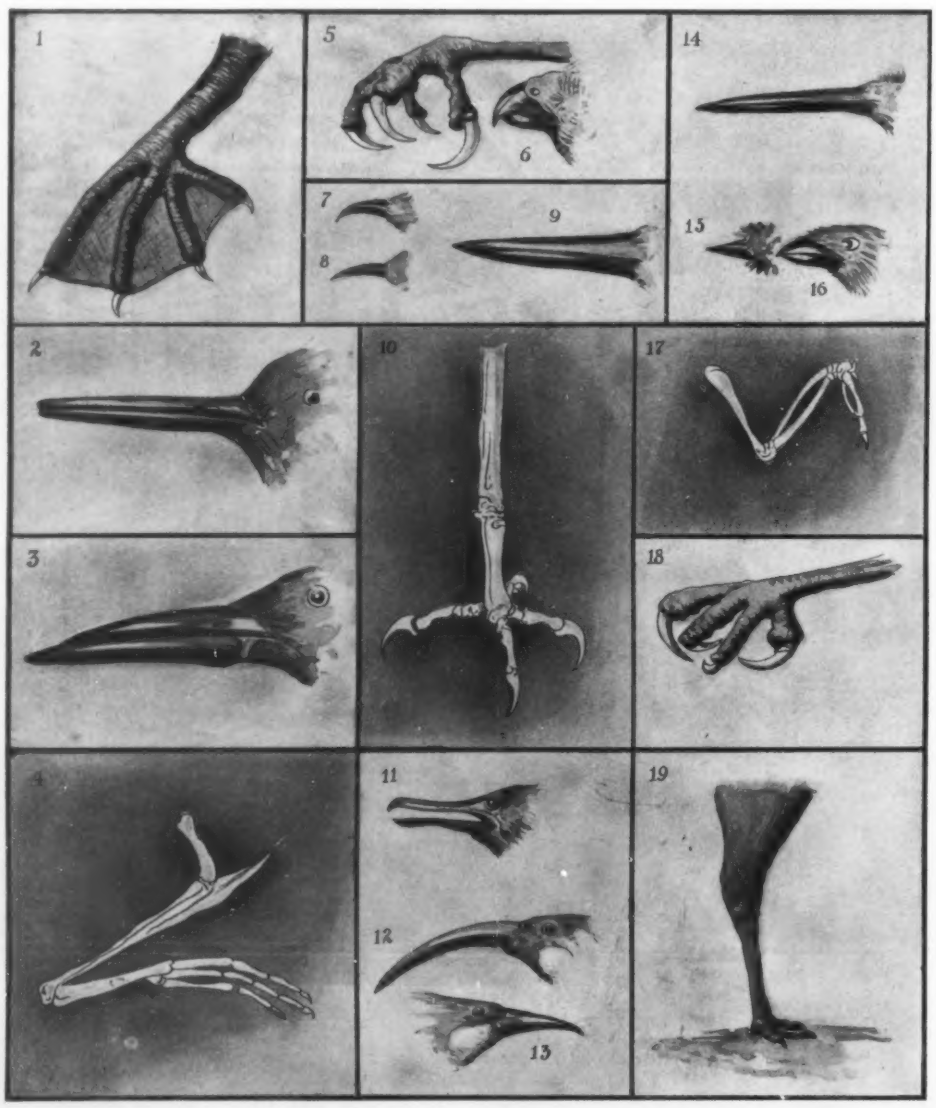
BY B. S. BOWDISH.

The casual observer knows the birds as he knows the tree, the stone, or the sea shell—an incidental object of passing interest; one of the trivial details in his every-day life. The novice bird student knows the birds, few or many species, by the clothes they wear, so to speak. If somewhat adept, he may even recognize birds by flight and song. Even the more profound ornithologist classifies birds by external character—largely bill, feet, length of wing and tail, number of feathers in each, etc. He is of necessity a specialist, paying particular attention to classification, pterography or the study of plumage; ornithological osteology, or some one of the sub-divisions of the general study of birds. Few individuals among any of the classes of students mentioned sufficiently appreciate the bird as a mechanism designed to play a certain part, every member, like every detail of some complicated and perfect machine, contributing toward perfecting the whole for its requirements.

Considering the bird from this standpoint, and analyzing the parts with a view to their functions, it seems natural to commence with the bill, because it is the anterior extremity and because of the importance of its uses. This one feature of a bird's mechanism merits treatment in an article especially devoted to it, and has, in fact, received such treatment.* It can be briefly reviewed only here. The bill not only performs the functions of a mouth in birds, but also serves as a hand. Having none at all on the posterior limbs, and only unsatisfactory substitutes on the anterior ones, birds must needs use the bill largely in lieu of a hand, and do so to a very considerable degree.

As has been shown, the bill largely conforms in shape to the requirements of the more important functions that it must perform, and exhibits a very wide range of variety in size and shape. It is used for cutting, tearing, and chewing food of various sorts, and for seizing, spearing, or engulfing prey. It is also used to dress the plumage, and by some species, such as parrots, to assist in climbing.

Birds' skulls, having a less diverse range of functions than the bills, show a correspondingly smaller degree of differentiation, but they do vary to some extent, according to the habits, and particularly according to the orders. In the lower types, such as grebes and loons, and most of the sea birds, the brain cavity is relatively small, but proportionately larger in the higher types, such as the thrushes, including the robin.



1. The bird's paddle; 2, the oyster catcher's bill; 3, black skimmer's bill; 4, bony structure of bird's foot; 5 and 6, bill and foot of Cooper's hawk; 7, vestiaria related to honeysuckles; 8, mamo's bill; 9, heron's bill; 10, the osprey's foot; 11, cormorant's bill; 12, huia (male) related to starlings; 13, huia (female); 14, egret's bill; 15 and 16, bill of drongo, related to slineks; 17, bones of a bird's wing; 18, foot of a barnyard fowl; 19, foot and leg of rhea, South American ostrich.

THE BIRD AS A MECHANISM.

The vertebral portion of the skeleton plainly indicates the bird's descent from ancestral stock common with that of reptiles. Modern birds being no longer provided with reptile-like tails, as was the case with the earliest types (the archeapteryx had twenty caudal vertebræ, the bony structure of a long, lizard-like tail, each vertebra supporting a long feather on either side) the number of caudal vertebræ has become reduced to usually nine, and these are short and with little apparent function, other than to support the feathers of the tail, fan-like, about the outer bone.

The bony structure of the wings is an adaptation of the bones of fore limbs to the requirements of flight. In evolutionary history this adaptation was principally accomplished in the lizard-like progenitors of birds, and the modifications since then are not remarkable. The main arm bone, the humerus, and the secondary ones, the ulna and radius, are not very different from the corresponding bones in mammals. In the hand, however, the first and fifth fingers have disappeared, the index and third digits are small and scarcely functional, while the middle finger is greatly developed, and furnishes the real bony support for the tip of the wing.

Wings for the great majority of birds are solely organs of flight; in a few species such as the ostrich they are rudimentary and functionless, serving at best only to preserve symmetry. In such species as penguins, however, while useless for flight, they are valuable as flippers or paddles, assisting progress through the water. In a very few cases they are used to assist the bird in climbing, usually largely while immature, as in the hoatzin of South America.

Next to the bills and wings, the feet of birds are perhaps of the greatest functional importance. Feet and legs vary greatly, according to the usage for which they are designed. In the ostrich, which most nearly resembles in its mode of life some wild horse, the development of feet and legs is strikingly like that of the feet and legs of such animals. Birds like the kingfisher and humming-bird, whose feet are used solely for perching, have absurdly underdeveloped, small, and weak-looking feet and legs. In the birds of prey the feet are practically grappling hooks, designed to secure the firmest hold of the victims; the legs are heavy and strong. Birds like the herons, the storks, and cranes, who spend much time wading, have very long legs and long, slender toes, which, spreading over a wider surface, give a support analogous to that afforded by snowshoes. This feature is more strikingly illustrated in birds like the rails, that travel about on the yielding aquatic growth, and finds its highest development in the jacanas, tropical and sub-tropical birds of the rail family. Woodpeckers, creepers, and nuthatches, birds that cling a great deal to perpendicular surfaces, have very sharp claws and feet adapted to such requirements. Birds that swim a great deal have the feet webbed with a membrane extending between the toes, making very efficient paddles.

The flesh of birds is no less efficiently designed and disposed toward the fulfilling of the requirements of the birds than the skeletal structure. The more important muscles are peculiarly designed to render the greatest efficiency. The powerful muscles that operate the wings have their anchorage on the keel of the breastbone, and the latter is particularly deeply developed in birds of most powerful flight. This is true alike of the man-of-war bird, with its immense wing area to maintain spread for hours in sailing, and of the humming bird with its relatively small wings, driven at lightning speed to keep the bird poised before a flower.

In all of the passerine or perching birds, the muscle and tendon arrangement of feet and legs is such that the weight of the body resting on and contracting the legs, draws the muscle over the main joint, and draws up on the ends of the toes, locking their grip on the perch. The same principle drives the talons of the hawks and owls into their prey.

Tongues in birds are also highly functional. In woodpeckers they are practically barbed spears, and the extreme protrusion that they are subject to is provided for by roots that extend around the back of the head and close up to the eye-sockets. In the humming bird the tongue is a pump for obtaining the nectar from flowers. In some species it is brush-like, to facilitate handling the food, and in certain fish-eating species the upper surface of the tongue is covered with points inclined backward, to facilitate swallowing the slippery prey.

The eyes of owls, designed to see at night, are wonderful structures. Only a small portion of the entire eye-ball is visible. Each socket occupies nearly a third of the total skull space. The visible eye-ball is mounted on a thin bone frame, somewhat resembling a lamp-shade in shape, a structure differing radically from the type of bird's eye.

The feathery covering of birds is especially adapted to their requirements. It is light, offering the least weight to be carried in flight, and a poor conductor of heat and cold, affording the best protection in the sudden temperature changes to which it is subjected. In birds like the penguins it is more like the hair of seals than normal feathers, and is thoroughly waterproof. The feathers of ducks and water fowl generally are also practically waterproof. The power of flight is quite dependent on the feathers, both of wings and tail, which in action are spread to give the greatest supporting area for the air pressure to act upon.

As a complete mechanism, so perfectly do all its parts contribute to an absolutely smooth-working whole, in the bird, that the very wonder of this intricate machine passes unnoticed as a common-place incident.

Metal filament lamps generally are supposed to be of a pretty frail nature, so that the slightest touch breaks them. This idea is counteracted by an account given in the Electrical World of a collision between a Pennsylvania eastbound passenger train and an empty engine just outside Jersey City on the morning of November 8th. This accident resulted in comparatively few injuries to the passengers, due to the fact that the strong frames of the passenger cars resisted crushing. The damage to engines and cars, however, was considerable. One of the steel passenger coaches jumped the track and turned over on its side, denting in the steel plates about 18 inches. Included in the lighting equipment of this car were nine tungsten lamps, and it is interesting to note that, after the wreck, these lamps were found to be in perfect condition.

* "Birds' Bills," by B. S. Bowdish, American Homes and Gardens, July, 1906, vol. iii, No. 1, pp. 33-37.

EXPERIMENTS IN CRYSTALLIZATION.

BY A. J. JARMAN.

The making of crystals of various kinds outside a chemical works or chemical laboratory is not often practised, because it is commonly considered that the subject is a very difficult one, or that it requires a complete knowledge of chemistry. Such, however, is a mistaken idea from either standpoint. Crystals of extraordinary beauty both in geometrical form and brilliancy of color can be produced by any person determined to make the undertaking successful.

The accompanying illustration shows a group of pyramidal crystalline structures that have been formed in the national colors.

The red is made of bichromate of potash, the white of common alum, and the blue of sulphate of copper.

Many salts can be employed that are very cheap, and after the crystals have been formed the solution left over can often be used. The geometrical forms of the crystals can be observed during their formation, and it is interesting to watch how they grow as the liquid deposits the excess of salt. When finished, they can be dried and preserved under a glass covering like wax flowers, so as to preserve them for ornament and for educational purposes.

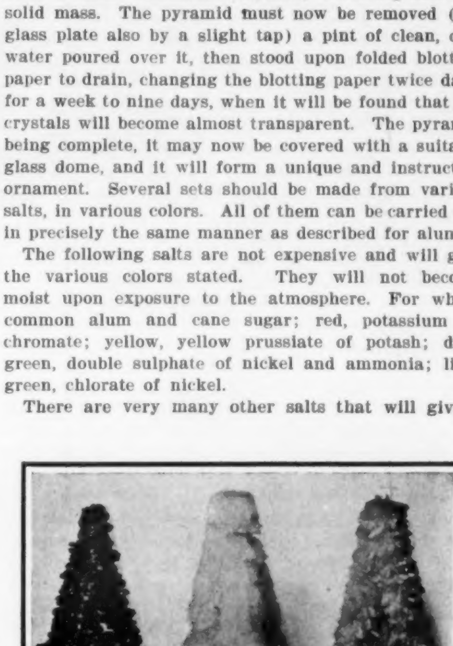
To produce results as illustrated, make a pyramid out of three pieces of wool, five inches long, and a quarter of an inch square. Wind each stick with cotton twine from end to end. Bind these three strips well at the apex of the pyramid and then for the base make a little triangle of the same sized strips, each piece being two and a half inches long. Cement these firmly at the corners with sealing wax, then cover every part neatly with a winding of cotton twine. Now distend the free ends of the three longer pieces, and fasten them to the base with sealing wax, after which carefully cover all the waxed parts with twine. For a fine pyramidal block of white transparent crystals prepare a small quantity of concentrated alum solution, made by adding powdered alum to a pint of boiling water, until no more will dissolve. Dip the cotton twine covered tripod or pyramid into this solution, let it soak for a minute, then stand it in a plate to cool. When cold it will be coated all over with very fine crystals of alum. This is the starting point to build up the final crystallization. Examine the minute crystals with a magnifying glass, when it will be seen that the face of each crystal is triangular in form, the corners being cut off. No matter how small or how large the crystal may be, it always assumes the same geometrical form; for every salt crystallizes in a form according to its nature.

Procure a two-gallon stoneware crock and a one-gallon glass battery jar. The battery jar should be eight inches high and six inches in diameter. Pour seven pints of boiling water into the stoneware crock. Add thereto about five pounds of powdered alum, a few ounces at a time, stirring the solution well with a clear strip of glass. As soon as the hot water will dissolve no more alum it is then saturated and must be poured into the glass battery jar, which has been previously warmed, straining the solution of alum by tying a three-fold piece of cheesecloth over the top of the jar. Now place in the battery jar a circular-like lid about ½ inch deep, such as the lid of a paste jar. Set upon this lid a piece of glass four and a half inches square, and upon the glass the slightly crystallized pyramid completely immersed in the solution and weighted down with a large alum crystal or a heavy glass stopper. A small crystal of alum may also be placed upon the top of the pyramid. All must now be left to cool gradually. Under no condition must the vessel be disturbed, because this would cause the alum to be thrown down in a few minutes in very fine crystals like common salt.

At the end of twenty-four hours, the whole of the pyramid will be covered with beautifully formed crystals. At the end of forty-eight hours, the pyramid may be removed, and the alum solution made hot once more, adding more ground alum to saturate the solution; pour this solution again into the battery jar and insert the pyramid with the sheet glass base; allow this to stand for a week, when it will be found to have become a mass of beautiful crystals, clustering into one solid mass. The pyramid must now be removed (the glass plate also by a slight tap) a pint of clean, cold water poured over it, then stood upon folded blotting paper to drain, changing the blotting paper twice daily for a week to nine days, when it will be found that the crystals will become almost transparent. The pyramid being complete, it may now be covered with a suitable glass dome, and it will form a unique and instructive ornament. Several sets should be made from various salts, in various colors. All of them can be carried out in precisely the same manner as described for alum.

The following salts are not expensive and will give the various colors stated. They will not become moist upon exposure to the atmosphere. For white, common alum and cane sugar; red, potassium bichromate; yellow, yellow prussiate of potash; dark green, double sulphate of nickel and ammonia; light green, chlorate of nickel.

There are very many other salts that will give a great variety of colors, the majority of them being deliquescent, becoming moist and melting upon exposure to the atmosphere, but those enumerated here will be permanent under all ordinary conditions.



RED, WHITE, AND BLUE PYRAMIDAL CLUSTERS OF CRYSTALS.

SIMPLE METHOD OF PRODUCING THE ZEEMAN EFFECT.

BY W. K. CARR.

The world was startled when, a few years ago, Prof. Zeeman announced that if pieces of sodium were burned between the poles of a powerful electro-magnet, the spectroscope would show the D line much broadened while the existing current was turned on, and that the original aspect of the line would be restored as soon as the current ceased.

The experiment confirmed the much-discussed theory of H. A. Lorentz, who assumed that the hitherto homogeneous and indestructible atom of the chemist was, as a matter of fact, heterogeneous and composed of minute particles or vortices in the ether of space, having a definite mass and possessing all the properties of negative electricity. These particles, or vortices, which are now called "electrons," he conceived as vibrating about the common center of gravity of the atom, and further, that light was due to transverse vibrations in the ether generated by these rapidly-moving electrons. If, argued Lorentz, the atom be made up of such particles or vortices, their rate of vibration would be altered by the lines of force in a magnetic field, and we should be able to predict their behavior with accuracy. Going back to two swinging pendulums for analogy, he pointed out that any motion to which the electron is subject could be resolved into three components, one in straight lines parallel to the lines of magnetic force, and the other two at right angles to them; but since these last two can be further resolved into two circular motions (one to the right and one to the left) around an axis parallel to the lines of force, we can say that the motion which the electrons are capable of making may be divided into component number 1, in which the electrons are moving parallel to the lines of force; component number 2, in which they move with the hands of the clock; and component number 3, in which they move against the hands of the clock. Now suppose we look at the vapor of sodium in a magnetic field and along the lines of force. Consider the electrons as negatively charged, and the lines of force running toward you, what will happen? You cannot see any effect of component number 1, since the electrons of that component are moving in the line of your vision, and since electrons emit waves only at right angles to the line of sight; hence to see the waves of component number 1, you would have to move your position, and look at the burning sodium at right angles to the lines of force. But with components numbers 2 and 3 the conditions are very different. Here the electrons are revolving in circular orbits, and in a plane at right angles to the line of sight; and since those which move with the hands of a watch are retarded, and those against the hands of a watch are accelerated, the single line seen in the spectroscope would split into two, or, as in Prof. Zeeman's case, where the spectroscope was of small dispersive power, only a broadening of line would be observed. This, then, was the experiment which startled the scientific world, startled it because one of the fundamental principles of science was apparently overthrown—the homogeneity of the atom of the chemist.

Notwithstanding its value and significance, the experiment is rarely witnessed, because of the ponderous and costly apparatus necessary to produce the division of the spectral lines. Powerful gratings and magnets, both exceedingly expensive, have up to the present time, been used in the demonstration. The writer, however, has a very simple piece of apparatus, costing less than $30, which shows the phenomenon admirably. No claim to originality is made, save in the matter of its arrangement, which is so simple as to be well within the grasp of any intelligent boy. Instead of the powerful spectroscope, the reader will observe in the accompanying photograph a little interferometer attached to the telescope. This is a modification of Fabry's, and for it the writer is indebted to the inventive genius and the exquisite mechanical ingenuity of Prof. Pfund of Johns Hopkins University. And instead of the huge magnet used by Zeeman, one weighing less than forty pounds is found more than ample. The photograph shows a piece of board six inches long to which is attached *A*, a lens of three inches focus, *B* a Nicol prism which can be revolved in its brass collar, *C* the interferometer, *D* the telescope, and *O* a spring clip for holding the quarter wave plate. This apparatus is simplicity itself, is always in adjustment, and can be rapidly shifted to view the phenomenon along the line of sight and at right angles to it.

Instead of burning sodium, let us use a tube containing helium gas, and place the apparatus so that we may view the light parallel to the lines of force and through the hole drilled in the pole piece of the magnet, as seen in Fig. 1. Examine the glowing tube before the magnet is energized, and you will see several concentric yellow rings in the field of the telescope.

Fix your attention upon any one of the rings which is the equivalent of the yellow line that would be seen in an ordinary spectroscope. Turn the current into the magnet, and instantly the yellow ring splits into two. Revolve the Nicol, but you cannot extinguish the rings, because, just as Lorentz predicted, they are circularly polarized. Now introduce a quarter wave plate, the effect of which is to produce a retardation of one-half wave length. The light is now plane polarized, and can be extinguished by the Nicol—a further and a beautiful confirmation of Lorentz's theory. So much for components numbers 2 and 3, but component number 1 cannot be seen, since its electrons are moving parallel to the lines of force. Now take out the Nicol, and move the apparatus so as to view the light at right angles to the lines of force. (Fig. 2.) Turn on the current, and one yellow ring is observed to break up into three. Let us analyze them, bearing in mind what Lorentz said, viz.: That one of these lines, component number 1, was polarized lying in a horizontal plane, and that the other two, components numbers 2 and 3, were polarized in a vertical plane, vertical because in this position we are looking at the edges of these circular vibrations, and the effect upon us is as if the particles were actually moving vertically. Now introduce the Nicol with its short diagonal vertical; two rings appear, and with the short diagonal horizontal one ring appears—a beautiful confirmation of one of the cleverest pieces of reasoning ever credited to the mind of man.

In the whole realm of physics there is nothing more

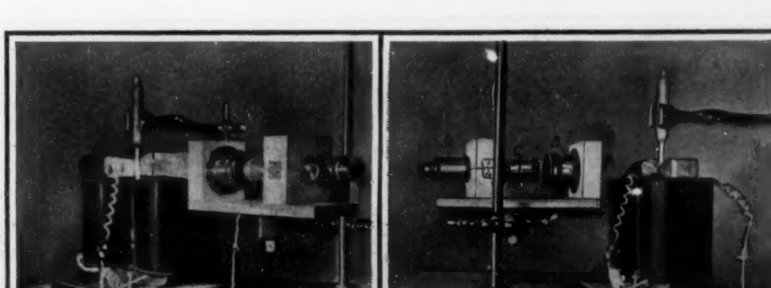


Fig. 1.—Looking in the direction of the magnetic lines. Fig. 2.—Looking at right angles to the magnetic lines.

APPARATUS FOR PRODUCING THE ZEEMAN EFFECT.

striking, more significant, and the effect which it is destined to exercise upon the future of science is simply incalculable.

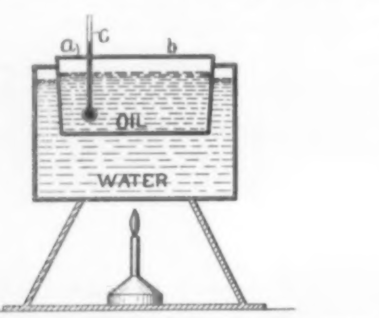
SOME SIMPLE TESTS FOR OILS.

BY RALPH P. CLARKSON.

There are several tests which anyone can apply without the use of special apparatus, and tell something about the grade of lubricating oil he is getting.

THE FLASH TEST.

Place a small amount of the oil to be tested in a



APPARATUS FOR DETERMINING THE FLASHING POINT OF OIL.

pan, as indicated at *a* in the accompanying engraving, and heat by means of the lamp beneath. As the oil heats, apply a match at *b*. After a time a flash is seen when the match is applied, but it disappears as rapidly as it came. This shows that enough vapor had been produced to mix with the air and form an explosive mixture. The temperature, given by thermometer *c*, at which this occurs, is called the flashing point. At some higher temperature, if a match is applied, the oil takes fire. This latter temperature is known as the burning point, and may be a considerable number of degrees above the flashing point.

TO DETECT THE PRESENCE OF AN ACID.

Dissolve a small amount of sodium carbonate in an equal volume of water. Place it, together with the oil to be tested, in a flask or beaker and shake thoroughly. The quantity of precipitate will be a gage of the amount of acid present.

TO DETECT THE PRESENCE OF GRIT.

Drop a small amount of the oil on white or very light-colored blotting paper. The oil will be absorbed, and the grit will be visible as small black specks on the blotter.

TO FIND THE TEMPERATURE AT WHICH THE OIL CONGEALS.

Put 15 parts of Glauber salts into a beaker. Place in this a bottle containing a sample of the oil. Place over the salt a mixture of 5 parts hydrochloric acid and 5 parts of cold water. The temperature is reduced slowly, and can be observed from time to time as the oil thickens. Any freezing mixture or even ice can be used in place of the above.

THE IONIZATION OF AIR.

SOME SIMPLE EXPERIMENTS.

The terms ions and electrons have now become familiar in the explanation of electrical phenomena. Most of the investigations upon which they are based however have been made *in vacuo*, and consequently they are but little understood, except by those scientists who have devoted their energies to their especial study. There are however many simple experiments, mostly due to Righi, which can be made in air at the ordinary pressure, and which form a useful introduction to the study of ionization. The accompanying illustrations represent some of these typical simple experiments performed by Mr. C. J. Watson of Birmingham, which aroused considerable interest at a recent scientific *conversazione* in that city, and through his courtesy we are able to explain how they were carried out and how they may be repeated by any interested reader.

It is well known that if a pointed wire be connected to one pole of an influence electric machine, and the other pole is earthed, a discharge of electricity will be obtained. The proof of electric discharge may be easily verified by means of a lighted candle and a gold-leaf electroscope. If the former is placed on the cap of the latter, the electroscope, even if disposed several yards from the machine, will collect continuously the electricity discharged from the machine. Similarly, if the action is carried out in the dark, a small stream of purple light may be seen, which although scarcely visible, will exercise a pronouncedly marked influence upon an exposed photographic plate. Another method in which this discharge may be ascertained is to place a condenser, comprising a piece of glass 1/16 inch thick coated on both sides with tinfoil to within ½ inch of its edge, opposite the point of the wire. Then connect the two opposite coatings of tinfoil with a strip of the same material, which has a fine cut in it. When the reverse side of the condenser is connected to earth, there will be a distinct spark jumping across the narrow gap.

If this discharge point then be immersed in a metal box, fitted with an opening which is covered with perforated zinc, so that the electrified air is forced through the perforations, if the box is earthed it will be found that the air which is thus expelled is totally deprived of electric charge. It thus appears that the

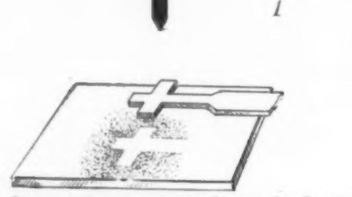


Fig. 1.—Interposing a non-conductor in the path of the ions.

electric charge is not carried by the particles of air generally, but by a smaller number of what for the present are generally described as ions.

Several simple experiments may be carried out to ascertain the paths pursued by these ions. For instance, take a sheet of ebonite, the reverse side of which is coated with tinfoil and earthed, and place it a foot distant from the discharge point. It is advisable to pass the sheet over a gas flame for a few seconds before each experiment, so that any electricity present in the sheet may be eliminated. When the discharge from the electric machine is carried out for about one second, the sheet will be charged sufficiently. No visible effect of this occurrence will be observable; but if the sheet is sprinkled with a mixture of powdered red lead and sulphur, and the same experiment is repeated with an obstacle of non-conducting material interposed between the discharge point and the sheet, such as say a cross, an image of that object will be produced upon the plate. If negative electricity has been discharged from the electrical point, then the sulphur will collect on those parts

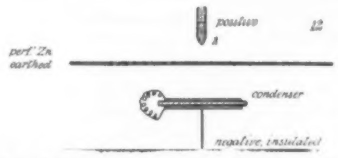


Fig. 12.—Forcing a discharge through a zinc sieve.

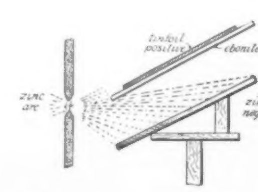


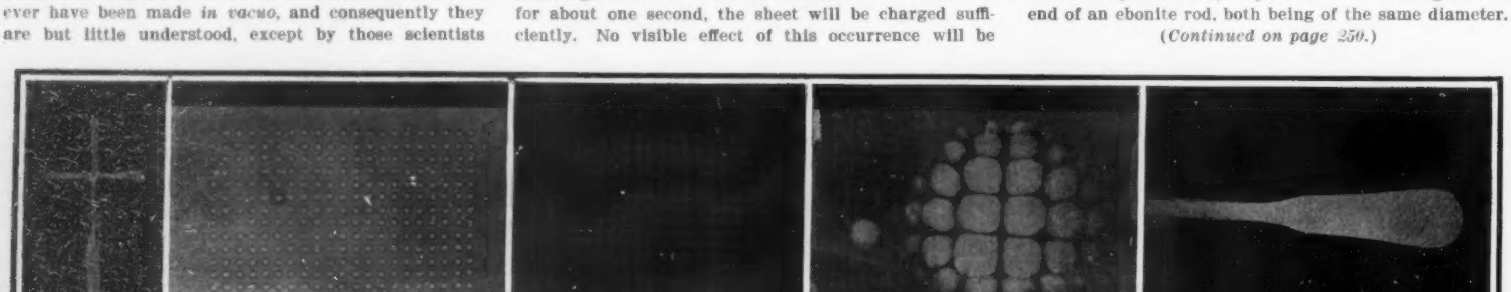
Fig. 13.—Effect of ultra-violet rays on zinc.

immediately beneath the object, while the red lead will adhere to those parts charged negatively by the unimpeded discharge on the surrounding areas. The drawing, Fig. 1, shows how the experiment is carried out, while the photograph, Fig. 2, gives the result of the interposition of the cross in the path pursued by the ions.

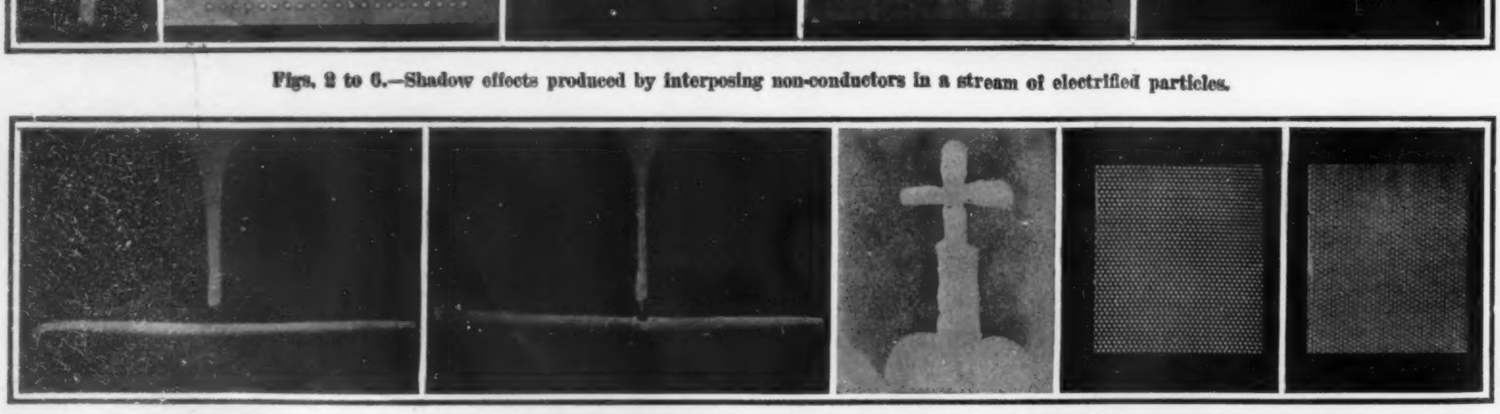
The image of the object is usually enlarged, but this factor is influenced to some extent by the length of time of the electric discharge. A preferable method is to take a sheet of celluloid, as shown in Fig. 3, perforated with holes at regular distances. Then when the image of these holes is obtained, as shown in Fig. 4, the distances between their centers can be measured. When the distance of the ebonite sheet is varied (the distance of the celluloid sheet from the electric pole being kept constant) it will be found that the size of the image grows with the distance, but not proportionately. The electrified particles or ions travel along the lines of electric force, and consequently generally in curved lines. This has been proved by using, instead of a point, a long thin wire held parallel to the interposed sheet of celluloid, when the lines of force are circular arcs passing through the wire, and striking the ebonite perpendicularly to its surface.

It will also be found that the streams of ions mutually repel each other, so that if the electrified point be very near to the celluloid, the individual images of the holes will be found to have enlarged themselves at the expense of the intervening spaces, and will even be observed to have assumed almost a square form, as shown in Fig. 5. This is of course analogous to what is observed with the cathode rays of highly exhausted tubes. A similar repulsion is also manifested when an insulated metal object is used as the interposed object. This is illustrated in Fig. 6, which represents the effect produced by a piece of brass tubing on the end of an ebonite rod, both being of the same diameter.

(*Continued on page 250.*)



Figs. 2 to 6.—Shadow effects produced by interposing non-conductors in a stream of electrified particles.



Figs. 7 to 11.—The effect of an air blast on the discharge, and of forcing a discharge through perforated zinc.

THE IONIZATION OF AIR.—SOME SIMPLE EXPERIMENTS.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

TELEPHONE-MUFFLER.—W. D. PLUMB, New York, N. Y. The invention relates especially to a device the purpose of which is to increase the distinctness of sound produced by the receiver, the operation of the device consisting in muffling or dampening the sounds which may be produced sympathetically or otherwise in the diaphragm of the transmitter.

PLUG FOR ELECTRICAL CONNECTIONS. —A. N. DODS, Mount Vernon, N. Y. The improvement has reference to plugs for electrical connections, the inventor's more particular purpose being to provide a construction suitable for plugs of large size and used in connection with powerful currents such as characterize automobile charging, theater dinners, and the like.

Of Interest to Farmers.

MACHINE FOR COLD-ROLLING DISKS.—A. L. DOW, Grover, Colo. The aim of this invention is to provide a device which is of light weight so that it may be carried about from place to place. It is so constructed that it can be carried into the field and readily attached to an engine used to reciprocate a plow, to drive the same. It relates to machines adapted to sharpen and roll disks used in plows, disk harrows, seeders, drills, etc.

HAY-FORK.—E. SWAN, Elko, Nev. The invention relates to a hay-fork of the grapple type, which is adapted to lift a large amount of hay, to unload the same from a wagon, and which is also adapted to readily deposit the said hay on a mow or stack. It is quick and positive in action, and strong and durable.

Of General Interest.

APPARATUS FOR PRINTING WOOD-GRAINING AND THE LIKE.—J. E. CURRENT and W. J. WESLEY, Erie, Pa. More particularly the invention pertains to a device adapted to be moved over a surface and print or produce thereon the semblance of wood graining. The main object is to so construct the apparatus that it may be used in producing a graining or printing on any stationary wall irrespective of its shape or position.

STERILIZER AND WATER-HEATER.—A. R. TALBOTT, Ellis, Kan. In this case the invention refers to sterilizers and water heaters especially designed for dentists' use, and the object is to provide in convenient form and at little cost, a device which will thoroughly sterilize instruments with boiling water, and will at the same time, heat water for cleasing the mouth.

VIOLIN-SUPPORTER.—H. A. SMITH, Danbury, Conn. The purpose of the inventor is to provide features of construction for a violin support, which are convenient in service, afford perfect freedom in handling the instrument, permit the quick, easy connection of the violin with the supporting device, and its release therefrom as may be desired.

BOAT-FLOORING.—F. SCHMIDT, New York, N. Y. For the purposes of this invention, a cushioned flooring is placed on a support in the vessel in such a manner that it is completely out of contact with the hull or other part of the vessel, so that the vibrations are absorbed by the cushion, and hence are not felt by the persons standing or seated on chairs set on the flooring.

Hardware and Tools.

RAZOR-STROP.—A. L. SILBERSTEIN, New York, N. Y. The strop is more especially designed for use in stropping thin razor blades, of the Gillette and other types, without much exertion on the part of the operator. For this purpose the rocker of the strop is adapted to receive a removable blade holder having retaining means for holding the razor blade in position. It relates to safety razor strops such as shown and described in Letters Patent of the U. S., formerly granted to Mr. Silberstein.

TOOL-HOLDER FOR PNEUMATIC HAMMERS.—V. E. LANE, Berwick, Pa. The most particular purpose here is to provide a construction adapted to the hammer, allowing the tool all necessary freedom and effectively preventing the tool from being unexpectedly ejected from the hammer so as to cause an accident.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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Petroleum products, apparatus for use in obtaining, H. Frasch	951,729
Petroleum products, obtaining, H. Frasch	951,272
Phonograms, duplicating, F. W. Matthews	951,483

(*Continued on page 248.*)

NEW AEROPLANES.

(*Continued from page 236.*)

weight of the machine complete is about 400 pounds. The thrust obtained from the propeller at 1,200 revolutions is in the neighborhood of 200 pounds. The double surface horizontal rudder is carried upon hollow inclined poles some 12 feet in advance of the main surface, and the single surface tail is similarly carried at the rear. The machine is mounted upon a central runner having two smaller skids at each side. There is also a skid at each end of the lower plane.

The novel features of this machine are the foot control of the horizontal rudder, and the system of triangular vertical fins on the top of the upper plane for the purpose of maintaining the transverse stability automatically. The aviator sits upon a small seat located in front of the lower plane, and clings to two inclined braces running out in front to vertical struts connecting the poles that hold the horizontal rudder. These inclined braces can be readily seen in the photograph, as well as the pedals for the feet of the aviator, which operate the horizontal rudder. The vertical rudder is worked by a small lever held in the aviator's right hand, and the spark and throttle control of the motor is also conveniently placed.

The theory upon which the transverse fins (each of which has about 2 square feet of surface) operate in order to maintain the transverse stability of the machine, is as follows: When the machine tips to one side, it has a tendency to slide down toward the ground endwise; but as the weight is placed very low, and as the fins offer resistance to this side motion, the upper part of the machine is retarded, while the lower part swings over like a pendulum, and the machine regains an even keel.

In the first test the surfaces (which are of special paraffin-coated silk) were very loose owing to fog and dampness, and once the machine was in the air, it was necessary for the aviator to sit well over to the left side, in order to counterbalance a difference in lifting power of the two sides of the machine. The biplane rose readily after a run of about 85 feet. The machine is said to have lifted at a speed of about 22 miles per hour. The horizontal rudder was turned too far, and the machine shot up to a height of 40 feet at an angle of nearly 30 degrees. Mr. Herring attempted to make a turn after flying some 300 feet, and the machine turned successfully, tipping inward at an angle of about 20 degrees from the horizontal, and making a 40-degree turn. He then cut off the spark and descended. In alighting the seat was split, and a runner and one of the inclined rods were broken. According to the inventor, the machine rose in the air with the aviator (who weighs 190 pounds) with a thrust of 140 pounds, and he believes that a thrust of 80 to 85 pounds is sufficient to fly it. The throttle was not fully opened, and the motor, he thinks, developed not more than 9 horse-power when the machine was in flight.

This biplane is the first aeroplane to fly in New England, but it is principally noteworthy because of the new method of automatic stability, which apparently seems to work fairly well.

Mr. Herring has replaced the vertical partitions of the Voisin biplane (which connect the main planes at the ends and at various points in between) by the six small triangular fins shown. If these small fins, placed above the upper plane, answer the purpose as well as do the partitions in the Voisin machine, one can readily see that they offer much less resistance and skin friction to the air, and should make a much faster machine. They form a means of automatic stability which is a decided improvement over warping wings or movable wing tips.

(*Continued on page 247.*)

(*Continued from page 246.*)

CAPT. BALDWIN'S BIPLANE.

One of our illustrations shows the new biplane of Capt. T. A. Baldwin, the dean of practical American aeronauts. This new biplane has a number of original features, chief of which is the method of preserving the transverse stability by means of a single vertical stability rudder placed above the upper plane. This rudder is turned about its vertical axis by means of a fork fitting around the aviator's shoulders, as in the Curtiss machine. When the aeroplane tips to one side or the other, by leaning to the high side the aviator sets the stabilizing rudder at an angle to the line of advance. This exerts sufficient force to bring the machine back to a level keel. The new stabilizing rudder is the outcome of experiments tried several years ago by the Aerial Experiment Association. It has been tried out by Mr. Curtiss, who claims that it worked satisfactorily upon his machine.

The new biplane has a spread of 28 feet by a fore-and-aft width of planes of 5 feet, which makes an area of 280 square feet of the main planes. In addition to these there is a small biplane tail carried on a triangular frame extending back from the main planes and mounted upon a light skid. The vertical rudder is placed in the center of this tail which forms in reality the horizontal rudder, since the two surfaces are moveable and are used to direct the machine up or down.

The arrangement of the power plant and aviator's seat is just the opposite of the usual arrangement, and is along monoplane lines. The motor is at the front edge of the lower plane and the aviator's seat above the rear edge. The flywheel of the motor extends below and above the plane. The propeller is placed half way between the upper and lower planes and is driven by chain from the motor. It is a large, high-pitch propeller of between 8 and 9 feet diameter.

The aeroplane is mounted upon two pneumatic-tired wheels in front and a single skid at the rear. The regular Curtiss single-wheel control of the rudders is fitted. The machine has had several successful tests upon the frozen surface of Lake Keuka, at Hammondsport, N. Y.

THE BLERIOT 1910 MODEL MONOPLANE.

The latest model Bleriot monoplane known as the "No. 11 *bis*" is shown from the rear in one of our illustrations on page 236. As can be seen at a glance, the body of the machine is now completely covered, while a new form of tail resembling that of the Antoinette monoplane has been fitted. The horizontal rudder is in two parts hinged at the rear edge of the tail proper. The spread of this new model is 7.2 meters (23.6 feet), the wings being about 11 x 7 feet in size and having an area of 12 square meters (129.6 square feet). The length of the body has been reduced from 7 to 6.6 meters (21.64 feet). The total weight is 310 kilogrammes (682.6 pounds), or with aviator 832 pounds. This means a lift of 6.45 pounds per square foot of the deeply curved surfaces. The highest lift per square foot heretofore obtained has been 5 pounds, so M. Bleriot has apparently improved his machine in this direction, although he has not diminished its weight but instead has increased it in order to give it greater strength. The same 3-cylinder, fan-shaped Anzani 25 horse-power air-cooled motor is used as heretofore. This motor develops its power at 1,400 revolutions per minute, at which speed it revolves the 6.82-foot Chauvière propeller. The pitch of the propeller is nearly half its diameter and the thrust obtained about 200 pounds. This new model is operated the same as his previous machines by a universally-jointed control column pushed forward or pulled backward to direct the machine down or up, while it is moved sideways to warp the wings and correct the transverse equilibrium.

SIR HIRAM MAXIM'S AEROPLANE.

BY R. P. HEARNE.

Authentic details are now available (*Continued on page 248.*)

(*Continued from page 247.*)

concerning the aeroplane which Sir Hiram Maxim has built at Crayford, Kent, England. No small degree of secrecy has been maintained; but to those who are acquainted with Sir Hiram's theories, it was evident that he would base the present aeroplane on the main principles which governed the design of the remarkable machine which he built and tested at Baldwyn's Park in 1894.

The present machine is the outcome of his original researches and of plans developed during the last five or six years, but not until 1908 was the veteran inventor able to devote himself fully to the planning of a new flying machine. He also set himself designing a gasoline motor, as he held the idea that much of the trouble with the present aeroplanes was due to the unsuitable engines employed. Sir Hiram has now evolved a flying machine in which every portion from engine to propellors has been constructed according to his own ideas. His first care was to reduce the proportions of the machine as compared with those of the gigantic apparatus which he constructed at Baldwyn's Park. The total width of the new aeroplane is 44 feet, while his earlier multiplane had a span of over 100 feet.

Like its prototype, the new aeroplane is of the multiplane type, and is in effect made up of six aeroplanes, each being 6 feet 6 inches in width, fore and aft. The planes are notably thin, and are neatly covered with waterproof silk fabric, very tightly laced. From the central plane spring out two superposed wings, raised well above it, and so curved as to produce automatic lateral stability to a very high degree. There are balanced rudders fore and aft, and a horizontal steering rudder. The Maxim patent device for varying the pitch of the planes when in flight is utilized. This differs from the Wright warping device. The wings are moved in one direction by a lever worked by hand, while a spring controls them in the reverse direction.

The engine is mounted between the planes, and behind the pilot, who sits in a low, metal-covered compartment, with the steering and control wheel in front of him. This disposition gives a very clear lookout, and at the same time the aviator is better protected from the wind. A highly novel feature is the propelling gear. On the engine shaft is one small screw propeller, mounted at the rear of the planes. This screw travels at the same rate as the engine shaft, and serves also as a flywheel. There are two larger propellers, each 11 feet in diameter, mounted higher up between the planes, and driven by cables whose tension is controlled by jockey pulleys. The small screw and one of the large ones rotate in the same direction, the other large one in the opposite direction. This screw is also given a finer pitch and higher velocity than its companion, and in this way its gyroscopic action balances the joint gyroscopic action of the two propellers, which rotate in the reverse direction. This arrangement of the screws is as ingenious as it is novel.

In the engine, too, Sir Hiram has shown how closely he has studied every phase of the problem. He has selected a special brand of Vickers steel as the material for his 4-cylinder 60-horsepower motor, and has been enabled to reduce weight while leaving a good margin of strength. Special care has been given to the carbureter and the valves. Sir Hiram claims that his engine works with far greater regularity and smoothness than the average aerial motor used on the Continent. The engine is fully water-cooled, and the radiator is mounted under the upper plane in a manner suggestive of that adopted by Santos Dumont on his little monoplane. A most ingenious system of automatic forced feed lubrication is employed,

(*Concluded on page 249.*)

(*Continued on page 250.*)

(Concluded from page 248.)

which carries oil to every working part of the engine in a very effective manner. Indeed, the new motor promises to set a splendid example in aeroplane engineering, for it shows that, by skillful designing and the choice of suitable material, a light motor can be built with all the refinements which are now usually fitted to high-grade engines for motor-car work. The spasmodic action of many aeroplanes at present in use is due largely to the fact that their engines are unreliable.

The new Maxim aeroplane is mounted on wheels fitted with neat shock absorbers. Regarding the machine as a whole, its clean lines and uncommon aspect are the most striking features. There is a noteworthy absence of the complication of stays, guy wires and framework, which on many biplanes cause so much head resistance. The grouping of the various organs has been very skillfully done, and as far as possible those parts which set up most resistance are set in the same lines, one behind the other, thus minimizing wind resistance. In effect the whole machine bears evidence of remarkable originality, both in its general form and in its main details. Sir Hiram does not yet propose to test it in free flight, as he has built an apparatus like that designed by the late Capt. Ferber, whereby the machine can circle in a captive state around a steel mast. When so many other machines, however, are experimented with in free flight by aviators of small experience, the Maxim method may not seem altogether necessary, although with a striking new type of machine it is undoubtedly a very sure course of procedure.

THE OLIVE BRIDGE DAM.

(Continued from page 238.)

cubic yards of rock excavation, and 7,200,000 cubic yards of embankment and refilling. The plant of the contractor at the Olive Bridge dam consists of four cableways, about 95 feet in height, which extend across the valley above the dam with a clear span of 1,530 feet. The crushing plant, with a capacity of 200 tons of crushed stone per hour, and the concrete mixing plant are located conveniently to the work, the material being brought below the cableways, by which it is deposited as desired along the structure. Work was begun in the fall of 1907, and at the present time about 25 per cent of it has been completed.

The total length of the aqueduct (which is 17½ feet wide by 17 feet in height) from the Ashokan reservoir to the city line is 92½ miles, and its cost will be about $45,000,000. To render the work perfectly secure and permanent, wherever the aqueduct encounters streams or rivers of any magnitude, it is carried beneath them either by deep pressure tunnels, or by steel and concrete pipes. The most notable pressure tunnel will be that below the Hudson River. In some respects this is the most interesting feature of the work; and we are informed by Mr. Alfred D. Flinn, Department Engineer of the Board of Water Supply, that the borings have revealed at great depth a granite rock eminently suited to carry this great and important conduit. In addition to a vertical boring made from a barge at the center of the river, which has reached a depth of 708 feet, two diagonal borings have been made one from either shore of the river. That from the eastern shore descends at an angle of 44 degrees for a distance of 1837 feet, where it has reached a point 70 feet from the center of the river. From the west shore, descending on an angle of 38 degrees, another boring has been driven for 1780 feet, which is now within 130 feet of the center of the river. The vertical shafts are now being sunk on either shore; they will be carried down to a depth of 1,200 feet below mean high-water level of the Hudson River at

(Concluded on page 250.)

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Wrench, G. Johnson	951,398
Yarns and fabrics by the special utilization of washed flax waste, manufacturing, Korselt & Thomas	951,251

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

(Concluded from page 249.)

this point. At that depth they will be connected by a horizontal tunnel. The aqueduct passes through the mountains, and reaches the westerly shore of the Hudson River at an elevation of 400 feet above tide level; and here vertical and horizontal shafts will connect with the 1,200-foot deep shaft at the immediate edge of the river, making a total depth of 1,600 feet from the flow line to the lowest level of the siphon. It is gratifying to realize that after the doubts and anxieties regarding the geological conditions affecting this work, its construction in solid granite has been assured. It should be mentioned that the whole siphon will be lined throughout with concrete.

At Kensico there is being built an auxiliary storage reservoir of about 40 billion gallons ultimate capacity, of which about 20 billion gallons will be available at flow line level. The elevation of the discharge will be 355 feet above mean tide. At Scarsdale, 4 miles south of Kensico, will be a large filtration plant; and at Hillview, 6 miles to the south of this, will be built another storage reservoir, with a capacity of 930 million gallons, the discharge being 295 feet above tide level.

The Kensico dam, which will be built across the valley of the Bronx, will be a masonry structure 290 feet high and 1830 feet long.

From the Hillview reservoir water will be carried to the several boroughs of the city in a pressure tunnel excavated deep down in the rock beneath the boroughs of Bronx and Manhattan and under the Harlem and East Rivers, to a point in the heart of Brooklyn, where it will be brought to the surface and continued in metal pipes, one branch leading north to the borough of Queens, and the other passing below the Narrows to Richmond at a point where the width is about 10,000 feet. The construction of this tunnel will confer the inestimable advantage that even at the lower end of Manhattan the water will rise to a height of 260 feet above sea level, or say to about the top of a 20-story building.

The total cost of the work, from and including Ashokan dam, to the city line, all of which is now under contract, is $69,094,870; and of this amount work to the value of $10,000,000 has been completed. The total cost of the whole scheme, when all the watersheds have been developed, will be $162,000,000.

IONIZATION OF AIR.

(Continued from page 244.)

The metal becoming charged gives a greatly enlarged shadow.

The ions travel in a strong electric field at the rate of several thousand feet per second, and it is not the air which conveys the charge, although it is dragged along by the ions in the same manner as it is by a jet of water. This can be demonstrated very easily by directing a blast of air at right angles to the path of the ions. Scarcely any deflection of the latter occurs. For instance, in Fig. 7 is shown the image of an ebonite rod and a glass tube produced in the manner already described. The next illustration represents the same objects with a strong blast of air thrown athwart the course of the ions. The effect of the blast is only shown issuing from the tube just beneath the rod. Otherwise the result is exactly the same as if there were no blast.

The experiments may be varied within a very wide limit, and an interesting variation is to use, instead of the ebonite sheet, a plate of metal well insulated and connected to the other pole of the electrical machine, instead of earthing the pole as previously described. On the sheet of metal lay a piece of paper, and upon this sprinkle filings, preferably a mixture of magnesium and black iron oxide. Between the sheet and the discharge pole, interpose an object as before, such as the cross, and when the

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electrical machine is set in action the filings will disappear from under the ebonite cross, giving a well-defined image, as shown in Fig. 9.

In the early part of this article it was pointed out that the electric discharge would not pass through perforated zinc under the circumstances there prevailing. But it can be made to do so. To bring about this result, place a plate of metal connected to the second pole of the machine beneath the ebonite sheet in such a way as to bring it opposite the discharge point *A* in Fig. 12. Sprinkle the surface of the ebonite sheet with the powdered red lead and sulphur, and interpose an earthed sheet of perforated zinc or a metallic sieve between the discharge point and the ebonite. When the electrical machine is set in action, a perfectly defined image of the perforations of the zinc obstacle will be obtained upon the ebonite sheet, as shown in Fig. 11. If the plate condenser with its connected sides of tinfoil, mentioned previously, is used, the passage of the ions through the perforations may be ascertained by the sparks jumping across the narrow gap. The explanation is that under the conditions described the electric field extends uninterruptedly from the point of discharge to the insulated metallic plate, so that the perforated sheet is in a perfectly neutral condition and scarcely intercepts the ions.

Several other striking and interesting methods of ionizing air can be carried out, such as by a flame, white-hot metals, electric sparks, and so on. One of the most impressive is that showing that ionization is produced by ultra-violet rays falling upon zinc. If a plate of clean zinc connected to a gold-leaf electroscope be negatively electrified, and illuminated by the light of burning magnesium, or better still by an electric arc between zinc electrodes, it is rapidly discharged. If the charge is positive, the phenomenon will not be produced. The experiment will also serve to show that these negative ions follow the definite paths of the lines of force. The illustration, Fig. 13, shows how to carry out this experiment. The tinfoil backing of the ebonite plate is connected to the positive pole of the machine. Opposite this plate and parallel therewith is placed a sheet of zinc, connected to the negative pole of the machine, leaving a clear width of about three inches between the two plates. The zinc plate is illuminated by the ultra-violet light from the zinc arc light for about a minute. Under these circumstances the lines of force run perpendicularly between the two plates, and if any design is painted in varnish upon the zinc plate, the emission of ions from that portion of the zinc will be arrested, and a reverse image of the design will be obtained on the ebonite plate when subsequently dusted with the powdered red lead and sulphur mixture.

The experiments of Sainte-Claire Deville and Caron apparently proved that the Oriental sapphire owes its beautiful color to the presence of a minute quantity of chromium in a state of oxidation lower than that which corresponds to the sesquioxide. It has not hitherto been found possible to reproduce the blue color with the aid of chromic oxide and reducing agents, nor yet to obtain, by fusion in the oxyhydrogen flame, artificial sapphires colored by traces of oxide of iron. If, however, a small quantity of titanic acid is added together with the oxide of iron, the reduction of the acid to titanium oxide takes place to such an extent that the mass fuses and assumes the fine blue color of the sapphire. This result has been obtained by Verneuil, who is of the opinion that in addition to sapphire colored by oxide of chromium, there is another variety which owes its color to oxides of iron and titanium. We have seen specimens of these artificial sapphires and to us they seem as beautiful as those of nature.